REPORT OF 14-DAY BEDREST SIMULATION OF SKYLAB

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INTRODUCTION

Medical aerospace research has offered scientists a unique challenge. They have had to ascertain whether spaceflight is safe for humans and what the effects of weightlessness are; they have had to predict whether physiological changes would be progressive and could pose safety questions to longer missions or whether the changes represented a new homeostatic equilibrium. Their efforts to address these problems have been severely circumscribed by the inherent nature of the research. The opportunities to study the effects of this unique environment have been few and infrequent, the population small. Because of conflicting demands on the astronaut's time and because of the practical and physiological limitations to the biological specimens which can be obtained, techniques have often been less refined than desired. Fortunately, bedrest has been found to be a useful model for simulating many of the physiological effects of weightlessness. Bedrest projects have enabled researchers to increase their fund of knowledge without the constraints of population size which characterizes spaceflight. In ground-based studies various parameters can be isolated and analyzed.

Since Skylab gave medical investigators one of their first opportunities for extensive and carefully controlled medical research not only pre- and postflight, but inflight, it seemed natural to extend these investigations to ground-based studies.

As a followup to Skylab, a two-phase bedrest project was planned involving a total of twelve subjects, six bedrested for two weeks and six for four weeks. The first phase is now complete and the second is scheduled for next summer.

Project Design

The project was designed to approximate as closely as possible the medical testing and dietary control of Skylab. During the entire test period, three weeks pre, two weeks bedrest, and two weeks post, the subjects ate measured amounts of the Skylab diet and drank deionized water to recreate the metabolic balance studies of Skylab.

As in Skylab water intake and output were recorded daily but insensible water loss was not measured. All urine and excrement were collected for analysis of contained minerals and hormones, etc. The medical testing program pre- and postbedrest was similar to that of Skylab, including most of the same experiments: lower body negative pressure testing the orthostatic intolerance noted after both spaceflights and bedrest, bicycle ergometry testing the cardiovascular response to graded exercise, postural equilibrium, vestibular studies and electromyograms. Fluid and electrolyte shifts and balance were documented with intake and output records and radionuclide studies. In addition, the subjects were followed and tested

by a psychiatrist who watched for signs of mental stress in the test environment and changes in mental status. None was found during the seven week investigation. Individual methods and protocols are described in the reports of the individual principal investigators.

The subjects were bedrested in two-four bed wards at The Methodist Hospital. For the pre- and postcontrol period, they lived in a special housing facility. Subjects were allowed relative freedom to pursue normal activity during the control period, pre- and postbedrest. During bedrest they could have visitors, watch TV, read books and magazines. This freedom enhanced their motivation and kept them mentally and physically alert, a situation more nearly approximating the busy challenging environment of the astronauts than would an isolation study. In the house environment, they lived with a group of individuals who had the same restrictions on life style as they did. They were therefore not tempted by food or beverages of which they could not partake. They were required to be in the housing facility by 11:00 PM every evening. The subjects complied with the rules and no infraction of the study rules were observed or reported to the project personnel.

Subject Selection

The six subjects of the first phase were normal, healthy

paid volunteers whose mean age was 30. Subjects were sought through two student placement offices connected with Houston universities, Rice University and the University of Houston, and through the Texas Employment Commission. All applicants were asked to complete a Methodist Hospital employee application form after which each potential subject had an interview of about an hour's duration with the project coordinator. The interview included an explanation of the project purpose, the nature of the medical experiments and questions concerning the subject's medical history, educational and work background and ambitions. The diet to be used during the program was shown to the applicants, and any food aversions or allergies were noted. The primary criteria used to determine which applicants would be sent for physicals were:

1. Age. We wanted a group with a mean age of at least 30. Subjects of this age group are more difficult to find than a younger population. Many adults whom we would consider dependable and conscientious have family, work or personal commitments which prevented their being subjects. Fewer in this age group are free of physical defects.

2. Size. Subjects under six feet were sought because that is the height limit for the astronaut corps. The weights of the subjects had to fall within ±10% of the ideal range

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published by the Metropolitan Life Insurance Company (Statistical Bulletin 40:1, 1959).

3. Food preferences. Because the diet was a very important part of the metabolic studies, it was necessary to seek subjects who could and would eat everything given them. Subjects with known food allergies and/or a known aversion to a major menu item were ruled out.

4. Attitude. Because the subjects were not to be isolated, but were to be allowed to attend classes and visit family and friends, mature, conscientious, highly motivated individuals were sought who could be trusted to rigidly adhere to the diet, to collect all excrement and not to smoke or take drugs during the study. Subject motivation was additionally important because in several of the medical experiments attitude and motivation can play a large role in the subject's response, particularly his desire to regain a normal physical state postbedrest. Individuals were naturally sought who would wholeheartedly complete any task they had begun.

5. Physical Fitness. All subjects were asked to run a mile and a half on a track at a nearby university. The time taken was measured. A subject was considered to be in adequate physical condition if his time fell in the good to excellent range according to the tables published by Cooper*.

Only eight of the 30 applicants filled the above criteria and were considered as potential candidates. A physician examined each subject and took a medical history. The applicants were examined by a psychiatrist and they filled out a MMPI. No psychiatric aberration was found in the test group. Tuberculin tests were performed. The medical screening tests included a stress EKG using a treadmill, a SMA-12, CBC and urinalysis. Each subject was asked to sign an informed consent form which had been approved by the College's Human Use Committee.

Results of Physicals

The six male subjects selected were described as follows by the medical examination team.

> Subject 1 is a 32-year old lawyer. He gave a history of having a ruptured tympanic membrane at age 15, which has healed. He is taking no medication and he denies drug allergy. He does no regular physical activity and is a light smoker, averaging a pack every five days. (He and Subject 3 did not smoke during the study. The remainder of the subjects were non-smokers.)
>
> On physical examination his height is 180 cm, weight 68.6 kg, blood pressure 130/90 and pulse 80. The general physical examination is unremarkable.
>
> Subject 2 is a 27-year old who has just finished his degree in history and political science and works sometimes as an automechanic. He wears corrective lenses for astygmatism. He takes no medication and denies drug allergy. At the age of three months he had surgical correction of a pyloric stenosis and

at the age of five he had a tonsillectomy. He was wounded in Viet Nam with a grenade fragment injuring his left leg which has left no residual deformity.

He states that he swims and plays handball and tennis.

On physical examination, his height is 182 cm, weight 70.4 kg, blood pressure 140/75 and pulse 88. The general physical examination is unremarkable.

Subject 3 is a 37-year old university professor. He admits to inner ear involvement associated with respiratory infections. He takes no medication. There is a possible allergic reaction to sulfa. He had a tonsillectomy at age 7. He had an automobile accident 6 months ago which caused a "herniated cervical disc." There was some associated paresthesias and muscle atrophy, but he states that this has subsequently cleared.

His time on the mile was excellent and he states that he jogs or plays handball several times a week. He smoked approximately 1½ packs a day until the beginning of the study.

On physical examination, his height is 175 cm, weight 68.6 kg, blood pressure 120/80 and pulse 96. The physical examination is unremarkable. No neurological abnormality is found.

Subject 4 is a 25-year old law student. He had a cartilage removed from his right knee about seven years ago, but has apparently been able to play football and participate in wrestling, etc. since that time. He had a tonsillectomy done twice in the past. His major physical activity is tennis.

On physical examination, height 170 cm, weight 65.3 kg, blood pressure 140/90 and pulse 100. There is some anterior-posterior instability of the right knee joint.

Subject 5 is a 32-year old railroad car mechanic. He admits to seasonal allergies with sneezing in October and November. He denies taking medication and has no drug allergy. He had a tonsillectomy.

In December of 1963 he had a cartilage removed from his left knee. He was subsequently accepted into the Marine Corps and upon jumping over a seven-foot wall, he reinjured the knee.

This subject participates in no sports. He previously lifted weights and his major physical activity is related to his job and carpentry work, which he does as a hobby.

His height is 169 cm, weight 81.3 kg, blood pressure 135/90, pulse 78. There is probable weakness of the right inguinal ring. The left knee reveals a healed surgical incision. The knee joint is stable.

Subject 6 is a 30-year old university student who loads mail for the postal service 3-4 hours a day. His history is negative. He is taking no medication and denies allergy. He had a tonsillectomy at age 14. He bicycles some and his job requires strenuous exertion.

On physical examination his height is 175 cm, weight 63.6 kg, blood pressure 130/70 and pulse 76. The general examination is unremarkable.

BEDREST STUDY MENU PLAN

A baseline 6-day cycle of menus to be evaluated by all subjects was planned for the bedrest study utilizing the nutritional constraints specified for Skylab. These general Skylab constraints are listed in Table 1 along with the nutritional levels of the baseline bedrest study menu cycle. Five (5) days prior to the beginning of the study subjects consumed the baseline menus and evaluated each food item. A sample food evaluation record which was used by each subject to score the baseline menu is depicted in Table 2. During the ambulatory control phase of the study, the baseline menu was modified for each subject to accommodate personal preferences, eating habits, and daily energy requirements. One of the subjects was found to be allergic to shellfish and became nauseous upon eating shrimp cocktail and/or lobster newburg. Daily energy requirements were determined for each subject using the method of adjusting caloric allowances for adults recommended by the Food and Nutrition Board of the National Research Council (Recommended Dietary Allowances, 7th Revised Edition, 1968, p. 5). This method is based upon age, body weight, and height, and recommends greater calorie allowances for increasing height and weight of individuals, but within given height-weight categories. Further adjustments for declining energy requirements for increasing age are also included.

Individual menus conformed to the general Skylab nutritional requirements. The Skylab nutritional requirements, as shown in Table 1, indicate the overall range of specific nutrients. After menu selection, this overall range is reduced for the daily variation in a given menu cycle. For example, Table 1

illustrates that the protein level for the Skylab experiments should be controlled at 90-125 $\pm$ 10 g. The individual menu cycles, as planned, ranged from 93 $\pm$ 6 to 116 $\pm$ 8 g protein. Skylab requirements and levels in individual menu cycles for other controlled nutrients are also listed in Table 1. Nutrient levels for individual bedrest menus are listed for each subject in Tables 3-8.

During the bedrest phase of the study, individual menus were again revised for some subjects due to changes in food preferences; however, nutritional levels of the revised menus were maintained within the individual levels established during the pre-bedrest phase of the study. Six-day menu cycles for each subject are shown in Tables 9-14.

Food utilized for the bedrest study was that manufactured for Skylab and had been analyzed for nutrient elements of interest in the Mineral Balance Experiment, M071. The food items used are listed in Table 15. Lot B food, which was the flight lot for the Skylab Food System, was used primarily; however, a number of items from Lot A, the development and test lot, were also incorporated into the menus due to the lack of available supplies of Lot B foods. Types of food included rehydratables, thermostabilized, natural form and frozen. Food was assembled into meals and transported to the site of food preparation for the study. When menus were revised for an individual, the food necessary to support the changes was transported to the site of the study and substitutions were made in the meal packs. Food was prepared and served at the site of the study according to menus and instructions supplied by NASA. A sample of the daily tally sheet which provided the menu, preparation instructions and space for recording any additional food consumed

or residue not consumed is included in Table 16. Data was collected by Baylor personnel and transmitted to NASA approximately weekly. If special problems were encountered, information was relayed by telephone. Dye markers (Carmine Red and FDC Blue #1) were administered at approximately 6-day intervals as shown in Table 17 to mark the repetition of each menu cycle. The intervals were determined by selecting the first day of the study, the first day of bedrest, and the first day of post-bedrest as marker days from which to calculate the subsequent 6-day periods. Each subject received a multi-vitamin tablet (Upjohn-Sigtabs) daily to simulate the dietary intake of SL-3 and SL-4 and to compensate for anticipated vitamin deterioration in foods.

TABLE 1. PLANNED NUTRITIONAL LEVELS OF BEDREST MENUS

Nutrient	Skylab Requirements	Baseline Bedrest Menus	SUBJECTS 1	2	3	6	4	5
Calories	2250-4250	2800	2900	2800	3100	2800	2800	2800
Protein g	90-125±10	101±10.5	108±6	98±7	116±8	93±6	101±5	103±8
Calcium mg	750-850±16	774±9	796±10	772±7	822±10	805±7	770±7	770±5
Phosphorus mg	1500-1700±120	1534±96	1661±103	1542±107	1722±122	1590±112	1560±100	1575±50
Magnesium mg	300-400±100	292±57	354±37	285±50	290±40	327±65	290±53	300±40
Potassium mg	>2740	3540±400	3976±311	3554±414	4284±388	3200±330	3530±545	3230±440
Sodium mg	3000-6000±500	6000±500	6100±500	4760±500	6150±500	5500±500	6000±500	6100±500

TABLE 2

NASA-JOHNSON SPACE CENTER

FOOD EVALUATION RECORD

Bed Rest Study Food Compatibility Test

MENU 1 MEAL Breakfast

Name ______________________ Date ______________

Food Rating:

1. We would like to find out your feelings regarding the foods listed below. Please rate each item according to the following code.
2. If there is a reason why you particularly like or dislike a food, briefly state it in the third column, along with your comments and suggestions.

RATING CODE:

9 - Like extremely
8 - Like very much
7 - Like moderately
6 - Like slightly
5 - Neither like nor dislike
4 - Dislike slightly
3 - Dislike moderately
2 - Dislike very much
1 - Dislike extremely

ITEM	RATING	COMMENTS
Pineapple		
Scrambled Eggs		
Bacon		
Rice Krispies		
Cocoa		

5. Please comment on this meal:

   A. Was the quantity of food too small? too large? adequate?

6. Would you like to switch any food items to another meal? If so, which items to which meal? It must be a meal on this same day.

7. Have you had either too much or not enough to eat today?

8. If you have had too much to eat, please indicate the item or items you would LIKE to delete from your menu.

TABLE 3. LEVELS OF SKYLAB-CONTROLLED NUTRIENTS IN BEDREST STUDY - PHASE I MENUS

Subject 1

Menu Day	Calories	Protein g	Ca mg	Phos mg	Mg mg	K mg	Na mg
1	2915	111.8	789	1764	355	3959	5600
2	2872	114.4	801	1724	391	3830	6357
3	2926	114.0	787	1704	367	4287	6600
4	2881	107.1	800	1559	320	3904	6609
5	2900	101.9	787	1625	317	3670	5600
6	2895	108.5	806	1585	362	3666	5600
Range	2872-2926	101.9-114.0	787-806	1559-1764	317-391	3666-4287	5600-6600
Menu Tolerance		108.0±6.1	796±10	1661±103	354±37	3976±311	6100±500
Skylab Tolerance		110.0±10	796±16	1660±120	350±100	>2740	6000±500
Skylab Range		100-120	780-812	1540-1780	250-450	>2740	5500-6600

TABLE 4. LEVELS OF SKYLAB-CONTROLLED NUTRIENTS IN BEDREST STUDY - PHASE I MENUS

Subject 2

Menu Day	Calories	Protein g	Ca mg	Phos mg	Mg mg	K mg	Na mg
1	2860	98.4	767	1577	277	3612	4753
2	2860	98.0	774	1510	334	3171	4260
3	2834	96.6	778	1648	302	3967	5260
4	2790	94.4	777	1435	286	3018	4867
5	2786	90.3	765	1438	235	3140	4260
6	2763	104.8	759	1579	287	3596	4260
Range	2763-2860	90.3-104.8	759-778	1435-1648	235-334	3140-3967	4260-5260
Menu Tolerance		97.6 ± 7.3	772 ± 7	1542 ± 107	285 ± 50	3554 ± 414	4760 ± 500
Skylab Tolerance		98 ± 10	772 ± 16	1582 ± 120	300 ± 100	>2740	4760 ± 500
Skylab Range		88-108	760-792	1422-1662	200-400	>2740	4260-5260

TABLE 5. LEVELS OF SKYLAB-CONTROLLED NUTRIENTS IN BEDREST STUDY-PHASE I MENUS

Subject 6

Menu Day	Calories	Protein g	Ca mg	Phos mg	Mg mg	K mg	Na mg
1	2798	92.6	798	1546	262	2873	5000
2	2774	91.3	812	1476	392	3528	5000
3	2808	90.0	810	1700	361	3537	5931
4	2825	87.2	806	1544	327	3167	5000
5	2830	98.4	805	1678	277	3120	5000
6	2753	94.3	802	1573	280	3147	5000
Range	2753-2830	87.2-98.4	798-812	1476-1700	262-392	2873-3537	5000-6000
Menu Tolerance		92.8 $\pm$ 5.6	805 $\pm$ 7	1590 $\pm$ 112	327 $\pm$ 65	3205 $\pm$ 332	5500 $\pm$ 500
Skylab Tolerance		93 $\pm$ 10	805 $\pm$ 16	1590 $\pm$ 120	300 $\pm$ 100	>2740	5500 $\pm$ 500
Skylab Range		83-103	789-821	1470-1706	200-400	>2740	5000-6000

TABLE 6. LEVELS OF SKYLAB-CONTROLLED NUTRIENTS IN BEDREST STUDY-PHASE I MENUS

Subject 4

Menu Day	Calories	Protein g	Ca mg	Phos mg	Mg mg	K mg	Na mg
1	2925	100.4	766	1591	281	3245	5500
2	2853	102.7	767	1625	339	3325	5500
3	2715	105.5	777	1658	314	4076	5500
4	2900	105.2	773	1463	289	3630	6505
5	2859	97.1	771	1590	323	3824	5500
6	2775	105.0	763	1579	237	2989	5500
Range	2715-2925	97.1-105.5	763-777	1463-1658	237-339	2989-4076	5500-6505
Menu Tolerance		101.3±4.2	770±7	1561±98	289±52	3533±544	6000±500
Skylab Tolerance		101±10	770±16	1561±120	300±100	>2740	6000±500
Skylab Range		91-101	754-786	1441-1681	200-400	>2740	5500-6500

TABLE 7. LEVELS OF SKYLAB-CONTROLLED NUTRIENTS IN BEDREST STUDY-PHASE I MENUS

Subject 5

Menu Day	Calories	Protein g	Ca mg	Phos mg	Mg mg	K mg	Na mg
1	2835	95.9	772	1558	338	3531	5600
2	2840	110.4	773	1611	326	3223	6378
3	2800	108.3	774	1621	300	3543	5600
4	2834	108.5	774	1602	281	3384	6025
5	2855	101.8	772	1579	310	3671	5600
6	2800	110.2	765	1525	260	2789	5600
Range	2800-2855	95.9-110.4	765-774	1525-1621	260-338	2789-3671	5600-6378
Menu Tolerance		103.2±7.3	770±5	1573±48	299±39	3230±441	5990±390
Skylab Tolerance		103±10	770±16	1573±120	300±100	>2740	6000±500
Skylab Range		93-113	754-786	1453-1693	200-400	>2740	5500-6500

TABLE 8. LEVELS OF SKYLAB-CONTROLLED NUTRIENTS IN BEDREST STUDY-PHASE I MENUS

Subject 3

Menu Day	Calories	Protein g	Ca mg	Phos mg	Mg mg	K mg	Na mg
1	3226	123.6	825	1843	332	4297	5640
2	3160	114.3	825	1784	413	4014	6295
3	3066	119.4	832	1774	374	4671	6031
4	3143	108.5	819	1600	358	4388	6639
5	3125	116.8	819	1732	346	4047	5640
6	3116	123.9	812	1773	396	3896	5640
Range	3066-3226	108.5-123.9	812-832	1600-1843	332-413	3896-4671	5640-6640
Menu Tolerance		116.2±7.7	822±10	1722±122	291±41	4284±388	6140±500
Skylab Tolerance		116±10	822±16	1722±120	300±100	>2740	6000±500
Skylab Range		106-126	806-838	1602-1842	200-400	>2740	5500-6500

TABLE 9. BEDREST STUDY - Subject 1

Meal	Menu 1	Menu 2	Menu 3
A	Bacon Squares Scrambled Eggs Rice Krispies Cocoa	Diced Pears Coffee Cake Chocolate Instant Breakfast Coffee	Canadian Bacon and Applesauce Scrambled Eggs Sugar Coated Cornflakes Coffee
B	Turkey Rice Soup Tuna Salad Sandwich Spread Bread Sliced Strawberries Vanilla Ice Cream Orange Drink	Pork Loin with Dressing and Gravy Buttered Asparagus Applesauce Tea with Lemon and Sugar	Chili Buttered Asparagus Soda Crackers Butter Pineapple Chunks Tea with Lemon and Sugar
C	Roast Beef Mashed Sweet Potatoes Buttered Asparagus Peach Ambrosia Coffee	Cubed Turkey with Gravy Mashed Potatoes Soda Crackers Butter Pineapple Chunks Coffee	Pea Soup Beef Hash Stewed Tomatoes Sliced Strawberries Coffee
Snacks	Peanuts Diced Peaches Coffee	Diced Peaches Dried Beef Buttered Roll Peach Ambrosia Strawberry Drink	Dry Roasted Peanuts Tuna Salad Spread Bread Orange Drink Grapefruit Juice

TABLE 9. BEDREST STUDY - Subject 1 (Continued)

Meal	Menu 4	Menu 5	Menu 6
A	Diced Peaches Sausage Rice Krispies Coffee	Scrambled Eggs Sugar Coated Cornflakes Coffee Cake Grapefruit Drink Coffee	Diced Peaches Sausage Scrambled Eggs Catsup Rice Krispies Coffee
B	Hot Dogs with Tomato Sauce Pork and Potatoes Green Beans with Mushroom Sauce Soda Crackers Butter Orange Drink	Cream of Tomato Soup Spaghetti and Meat Sauce Soda Crackers Diced Pears Tea with Lemon and Sugar	Pea Soup Salmon Salad Soda Crackers Pineapple Chunks Tea with Lemon and Sugar
C	Chicken Chunks with Gravy Mashed Potatoes Stewed Tomatoes Diced Pears Grapefruit Juice	Roast Beef Macaroni and Cheese Asparagus Diced Peaches Cocoa	Lobster Newburg Stewed Tomatoes Peach Ambrosia Tea with Lemon and Sugar
Snacks	Dry Roasted Peanuts Cheese Crackers Coffee	Peanut Butter Bread Coffee	Peanut Butter Bread Diced Pears Coffee

TABLE 10. BEDREST STUDY - Subject 6

Meal	Menu 1	Menu 2	Menu 3
A	Canadian Bacon and Applesauce Scrambled Eggs Rice Krispies Cocoa	Diced Pears Coffee Cake Chocolate Instant Breakfast Apple Drink	Pineapple Chunks Scrambled Eggs Sugar Coated Cornflakes Cocoa
B	Turkey Rice Soup Tuna Salad Sandwich Spread White Bread Sliced Strawberries Vanilla Ice Cream Strawberry Drink	Pork Loin with Dressing and Gravy Green Beans with Mushroom Sauce Applesauce Grape Drink	Turkey Rice Soup Peanut Butter White Bread Lemon Pudding Strawberry Drink
C	Roast Beef Macaroni and Cheese Asparagus Peach Ambrosia Grape Drink	Chicken Chunks with Gravy Mashed Potatoes Cream Style Corn Diced Peaches Cocoa	Pea Soup Chicken and Rice Stewed Tomatoes Sliced Strawberries Grapefruit Juice
Snacks	Pineapple Chunks Apple Drink Cherry Drink	Dry Roasted Peanuts	Dry Roasted Peanuts Strawberry Drink

TABLE 10. BEDREST STUDY - Subject 6 (Cont'd)

Meal	Menu 4	Menu 5	Menu 6
A	Applesauce Rice Krispies Coffee Cake Chocolate Instant Breakfast Apple Drink	Scrambled Eggs Cornflakes Coffee Cake Grapefruit Drink Cocoa	Diced Peaches Scrambled Eggs Rice Krispies Cocoa
B	Pork and Potatoes Buttered Roll Diced Peaches Grape Drink	Spaghetti with Meat Sauce Creamed Peas Diced Pears Grape Drink	Pea Soup Salmon Salad White Bread Pineapple Chunks Cherry Drink
C	Cubed Turkey and Gravy Mashed Potatoes Cream Style Corn Soda Crackers Diced Pears Cherry Drink	Roast Beef Macaroni and Cheese Asparagus Lemon Pudding Strawberry Drink	Lobster Newburg Pork and Potatoes Asparagus Peach Ambrosia Grape Drink
Snacks	Grape Drink Apple Drink	Peanut Butter White Bread	Lemon Pudding

TABLE 11. BEDREST STUDY - Subject 4

Meal	Menu 1	Menu 2	Menu 3
A	Diced Pears Bacon Bits Scrambled Eggs Rice Krispies Cocoa	Diced Pears Coffee Cake Chocolate Instant Breakfast Strawberry Drink	Canadian Bacon and Applesauce Scrambled Eggs Cornflakes Grapefruit Drink
B	Turkey Rice Soup Peanut Butter Bread Sliced Strawberries Vanilla Ice Cream Strawberry Drink	Pork Loin with Dressing and Gravy Asparagus Applesauce Lemon Pudding Grape Drink	Chili Asparagus Biscuit Lemon Pudding Apple Drink
C	Roast Beef German Potato Salad Asparagus Diced Peaches Strawberry Drink	Cubed Turkey with Gravy Mashed Potatoes Cream Style Corn Buttered Roll Peach Ambrosia Cherry Drink	Shrimp Cocktail Beef Hash Stewed Tomatoes Sliced Strawberries
Snacks	Lemon Pudding		Dry Roasted Peanuts Strawberry Drink Dinner Mints

TABLE 11. BEDREST STUDY - Subject 4 (Cont'd)

Meal	Menu 4	Menu 5	Menu 6
A	Applesauce Sausage Rice Krispies Apple Drink	Diced Peaches Scrambled Eggs Cornflakes Coffee Cake Grapefruit Drink	Diced Peaches Sausage Scrambled Eggs Rice Krispies Strawberry Drink
B	Hot Dogs with Tomato Sauce Pork and Potatoes Green Beans with Mushroom Sauce Strawberry Drink	Spaghetti with Meat Sauce Stewed Tomatoes Diced Pears Grape Drink	Pea Soup Salmon Salad Soda Crackers Diced Pears Cherry Drink
C	Chicken and Gravy Mashed Potatoes Stewed Tomatoes Diced Pears Grapefruit Juice	Roast Beef Macaroni and Cheese Asparagus Peach Ambrosia Cocoa	Lobster Newburg Pork and Potatoes Asparagus Peach Ambrosia Grape Drink
Snacks	Cheese Crackers Dry Roasted Peanuts	Dry Roasted Peanuts Applesauce	Lemon Pudding

TABLE 12. BEDREST STUDY - Subject 5

Meal	Menu 1	Menu 2	Menu 3
A	Pineapple Chunks Scrambled Eggs Rice Krispies Cocoa	Diced Pears Coffee Cake Chocolate Instant Breakfast	Canadian Bacon and Applesauce Scrambled Eggs Rice Krispies Grapefruit Drink
B	Turkey Rice Soup Tuna Salad Sandwich Spread Bread Sliced Strawberries Vanilla Ice Cream Strawberry Drink	Pork Loin with Dressing and Gravy Applesauce Asparagus Lemon Pudding Grape Drink	Chili Asparagus Bread Lemon Pudding Apple Drink
C	Roast Beef Sweet Potatoes Asparagus Peach Ambrosia Apple Drink	Cubed Turkey with Gravy Mashed Potatoes Pineapple Chunks Strawberry Drink	Shrimp Cocktail Beef Hash Green Beans with Mushroom Sauce Sliced Strawberries Strawberry Drink
Snacks	Dry Roasted Peanuts	Dried Beef Buttered Roll Lemon Drops	Dry Roasted Peanuts Dinner Mints

TABLE 12. BEDREST STUDY - Subject 5 (Cont'd)

Meal	Menu 4	Menu 5	Menu 6
A	Sausage Rice Krispies Strawberry Drink	Scrambled Eggs Sugar Coated Cornflakes Coffee Cake Grapefruit Drink	Sausage Scrambled Eggs Rice Krispies Apple Drink
B	Hot Dogs with Tomato Sauce Pork and Potatoes Green Beans with Mushroom Sauce Biscuit Strawberry Drink	Tomato Soup Spaghetti with Meat Sauce Bread Diced Pears Strawberry Drink	Pea Soup Salmon Salad Bread Pineapple Chunks Cherry Drink
C	Chicken and Rice Mashed Potatoes Asparagus Diced Pears Grapefruit Juice	Roast Beef German Potato Salad Asparagus Pineapple Chunks Cocoa	Lobster Newburg Pork and Potatoes Asparagus Peach Ambrosia Grape Drink
Snacks	Dry Roasted Peanuts Cheese Crackers	Dry Roasted Peanuts	Lemon Pudding

TABLE 13. BEDREST STUDY - Subject 2

Meal	Menu 1	Menu 2	Menu 3
A	Diced Pears	Diced Pears	Canadian Bacon and Applesauce
	Bacon Squares	Coffee Cake	Scrambled Eggs
	Scrambled Eggs	Chocolate Instant Breakfast	Sugar Coated Cornflakes
	Rice Krispies	Coffee with Sugar	Grapefruit Drink
	Cocoa		Coffee with Sugar
B	Turkey Rice Soup	Pork Loin with Dressing and Gravy	Chili
	Tuna Salad Sandwich Spread	Applesauce	Asparagus
	Bread	Asparagus	Lemon Pudding
	Sliced Strawberries	Lemon Pudding	Apple Drink
	Vanilla Ice Cream	Grape Drink	
	Orange Drink		
C	Roast Beef	Cubed Turkey with Gravy	Beef Hash
	Mashed Sweet Potatoes	Mashed Potatoes	Stewed Tomatoes
	Asparagus	Pineapple Chunks	Sliced Strawberries
	Peach Ambrosia	Coffee with Sugar	Cocoa
	Coffee with Sugar		
Snacks	Lemon Pudding	Buttered Roll	Peanut Butter
	Coffee with Sugar	Lemon Drops	Bread
		Strawberry Drink	Orange Drink

TABLE 13. BEDREST STUDY - Subject 2 (Cont'd)

Meal	Menu 4	Menu 5	Menu 6
A	Sausage Scrambled Eggs Rice Krispies Coffee with Sugar	Scrambled Eggs Sugar Coated Cornflakes Coffee Cake Grapefruit Drink Coffee with Sugar	Diced Pears Scrambled Eggs Rice Krispies Coffee with Sugar
B	Pork and Potatoes Green Beans with Mushroom Sauce Soda Crackers Grape Drink	Cream of Tomato Soup Spaghetti and Meat Sauce Bread Diced Pears Grape Drink	Pea Soup Salmon Salad Bread Pineapple Chunks Orange Drink
C	Chicken Chunks with Gravy Mashed Potatoes Asparagus Diced Pears Grapefruit Juice	Roast Beef Macaroni and Cheese Asparagus Cocoa	Filet Mignon Green Beans with Mushroom Sauce Stewed Tomatoes Peach Ambrosia Strawberry Drink
Snacks	Cheese Crackers Dry Roasted Peanuts Dinner Mints Diced Peaches Apple Drink Coffee with Sugar	Lemon Drops Coffee with Sugar	Lemon Pudding Coffee with Sugar

TABLE 14. BEDREST STUDY - Subject 3

Meal	Menu 1	Menu 1 (Revised 5-30-75)	Menu 2	Menu 3
A	Applesauce	Applesauce	Diced Pears	Scrambled Eggs
	Scrambled Eggs	Scrambled Eggs	Coffee Cake	Sugar Coated Cornflakes
	Rice Krispies	Rice Krispies	Chocolate Instant Breakfast	Grapefruit Drink
	Cocoa	Cocoa	Coffee	Coffee
	Coffee	Coffee		
B	Turkey Rice Soup	Turkey Rice Soup	Pork Loin with Dressing and Gravy	Chili
	Salmon Salad	Salmon Salad	Buttered Asparagus	Buttered Asparagus
	Soda Crackers	Soda Crackers	Applesauce	Soda Crackers
	Sliced Strawberries	Sliced Strawberries	Grape Drink	Applesauce
	Vanilla Ice Cream	Vanilla Ice Cream	Coffee	Tea with Lemon and Sugar
	Orange Drink	Orange Drink		Coffee
	Coffee	Coffee		
C	Roast Beef	Roast Beef	Cubed Turkey with Gravy	Shrimp Cocktail
	Mashed Sweet Potatoes	Mashed Potatoes	Mashed Potatoes	Beef Hash
	Buttered Asparagus	Buttered Asparagus	Pineapple Chunks	Stewed Tomatoes
	Peach Ambrosia	Peach Ambrosia	Coffee	Sliced Strawberries
	Coffee	Coffee		Coffee
Snacks	Bacon Bits	Bacon Bits	Diced Peaches	Canadian Bacon and Applesauce
	Tuna Salad Sandwich Spread	Tuna Salad Sandwich Spread	Dried Beef	Dry Roasted Peanuts
	Bread	Bread	Buttered Roll	Tuna Salad Sandwich Spread
	Diced Peaches	Diced Peaches	Peach Ambrosia	Bread
	Tea with Lemon and Sugar	Tea with Lemon and Sugar	Orange Drink	Diced Peaches
	Coffee	Coffee	Coffee	Orange Drink
			Tea with Lemon and Sugar	Tea with Lemon and Sugar
			Lemon Drops	

TABLE 14. BEDREST STUDY - Subject 3 (Cont'd)

Meal	Menu 4	Menu 4 (Revised 5-30-75)	Menu 5	Menu 6
A	Sausage Rice Krispies Coffee X 2	Sausage Sugar Coated Cornflakes Coffee X 2	Scrambled Eggs Sugar Coated Cornflakes Coffee Cake Grapefruit Drink Coffee	Diced Peaches Sausage Scrambled Eggs Catsup Rice Krispies Coffee
B	Pork and Potatoes Green Beans with Mushroom Sauce Soda Crackers Butter Applesauce Orange Drink Coffee	Salmon Salad Pork and Potatoes Green Beans with Mushroom Sauce Soda Crackers Butter Applesauce Orange Drink Coffee	Cream of Tomato Soup Spaghetti and Meat Sauce Diced Pears Grape Drink Coffee	Pea Soup Salmon Salad Biscuit Pineapple Chunks Tea with Lemon and Sugar Coffee
C	Chicken Chunks with Gravy Mashed Potatoes Stewed Tomatoes Diced Pears Grapefruit Juice Coffee	Chicken Chunks with Gravy Mashed Potatoes Stewed Tomatoes Cream Style Corn Diced Pears Grapefruit Juice Coffee	Roast Beef Macaroni and Cheese Asparagus Pineapple Chunks Cocoa Coffee	Lobster Newburg Pork and Potatoes Asparagus Peach Ambrosia Grape Drink Coffee
Snacks	Cheese Crackers Dry Roasted Peanuts Hot Dogs with Tomato Sauce Diced Peaches Tea with Lemon and Sugar Coffee	Cheese Crackers Dry Roasted Peanuts Diced Peaches Tea with Lemon and Sugar Coffee	Bacon Bits Peanut Butter Bread Tea with Lemon and Sugar Coffee	Peanut Butter Bread Diced Pears Coffee

TABLE 15. SKYLAB FOODS USED FOR BEDREST STUDY-PHASE I

Food No.	
1	Salt (Reagent Grade)
2	Grapefruit Juice (Lot A) (B)
3	Tuna Salad Sandwich Spread (Lot B) (T)
4	Lemon Pudding (Lot B) (T)
5	Dry Roasted Peanuts (Lot B) (N)
6	Vanilla Ice Cream (Lot A) (F)
7	Sugar Cookies (Lot A) (C)
8	Salt-free Butter (N)
11	Cheddar Cheese Crackers (Lot B) (C)
12	Dinner Mints (Lot B) (N)
13	Sausage Patties (Lot B) (R)
14	Cornflakes (Lot A) (R)
15	Cornflakes (Lot B) (R)
16	Scrambled Eggs (Lot B) (R)
17	Bacon (Lot A) (C)
18	Filet Mignon (Lot A) (F)
19	Frozen Bread (Lot A) (F)
20	Catsup (Lot B) (N)
22	Asparagus (Lot B) (R)
23	Lemonade (Lot B) (B)
24	Buttered Roll (Lot B) (LF)
25	Salmon Salad (Lot B) (R)
26	Pork Loin w/Dressing and Gravy (Lot A) (F)
27	Strawberries (Lot B) (R)
28	Vanilla Wafers (Lot B) (N)
30	Canadian Bacon and Applesauce (Lot A) (R)
31	Coffee Cake (Lot A) (F)
32	Mashed Potatoes (Lot B) (R)
33	Peanut Butter (Lot B) (T)
34	Chili (Lot B) (T)
35	Tomato Soup (Lot A) (R)
36	Fruit Jam (Lot A) (T)
37	Pea Soup (Lot B) (R)
38	Pineapple (Lot B) (T)
39	Lobster Newburg (Lot B) (F)
40	Turkey and Gravy (Lot B) (T)
41	Lemon Drops (Lot B) (N)

B = Beverage
T = Thermostabilized
N = Natural Form
F = Frozen
C = Compressed
R = Rehydratable

TABLE 15. SKYLAB FOODS USED FOR BEDREST STUDY-PHASE I (CONTINUED)

Food No.	
42	Grape Drink (Lot B) (B)
43	Applesauce (Lot B) (T)
44	Hot Dogs w/Tomato Sauce (Lot B) (T)
46	Peaches (Lot B) (T)
47	Pears (Lot B) (T)
48	Biscuits (Lot B) (N)
49	German Potato Salad (Lot B) (R)
50	Chocolate Instant Breakfast (Lot B) (B)
51	Shrimp Cocktail (Lot B) (R)
52	Turkey Rice Soup (Lot A) (R)
53	Turkey Rice Soup (Lot B) (R)
54	Rice Krispies (Lot B) (R)
55	Chicken and Rice (Lot B) (R)
56	Creamed Peas (Lot A) (R)
57	Chicken and Gravy (Lot A) (R)
58	Cocoa (Lot B) (B)
59	Pork and Potatoes (Lot B) (R)
60	Orange Drink (Lot B) (B)
61	Sweet Potatoes (Lot B) (R)
62	Coffee (Lot A) (B)
63	Beef Hash (Lot B) (R)
64	Stewed Tomatoes (Lot B) (T)
65	Cream Style Corn (Lot A) (R)
66	Tea w/Lemon and Sugar (Lot B) (B)
67	Dried Beef (Lot B) (T)
68	Prime Rib (Lot A) (F)
69	Peach Ambrosia (Lot B) (R)
72	Spaghetti (Lot B) (R)
73	Green Beans (Lot A) (R)
74	Macaroni and Cheese (Lot B) (R)
75	Canned Bread (Lot B) (T)
76	Butter Cookies (Lot A) (N)
77	Apple Drink (Lot B) (B)
78	Cherry Drink (Lot B) (B)
79	Grapefruit Drink (Lot B) (B)
80	Strawberry Drink (Lot B) (B)
81	Coffee w/Sugar (Lot B) (B)

B = Beverage　　F = Frozen
T = Thermostabilized　　C = Compressed
N = Natural Form　　R = Rehydratable

Table 16

COMPOSITION OF A SIGTAB TABLET

Vitamin A	5,000 Int. Units
Vitamin D	400 Int. Units
Thiamine Mononitrate	10 mg
Riboflavin	10 mg
Ascorbic Acid (as sodium ascorbate)	333 mg
Niacinamide	100 mg
Pyridoxine Hydrochloride	2 mg
Calcium Pantothenate	20 mg
Folic Acid	0.033 mg
Cobalamin (as cobalamin concentrate)	4 mcg
Vitamin E	15 Int. Units

THE EFFECTS OF 14-DAYS HORIZONTAL BEDREST ON SUSCEPTIBILITY TO CORIOLIS MOTION SICKNESS, POSTURAL STABILITY AND NEURO-MUSCULAR REFLEX ACTIVITY

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INTRODUCTION

Pre-, in- and postflight observations and data obtained during the recently completed Skylab missions revealed a number of interrelated clinical, behavioral and sensory-physiological responses presumably caused by prolonged exposure to the weightless space flight environment. First, upon initial entry into weightlessness, five of the nine crewmen experienced symptoms characteristic of motion sickness. Symptoms ranged from mild (stomach awareness) to severe (vomiting) and in most cases persisted for three to five days. Adaptation to the weightless environment occurred by approximately mission day seven for all of the crewmen and subsequent tests utilizing the Skylab M131 Rotating Litter Chair showed surprisingly that all of the crewmen had become virtually immune to experimentally induced motion sickness. Of particular relevance to the present study were the results of motion sensitivity tests conducted postflight. These tests revealed that relative to their preflight baseline levels, all of the crewmen were less susceptible to motion sickness during the postflight period. Although considerable variability was present among the crewmen, the magnitude and duration of this change was related in a slightly positive fashion to the duration of 0-g exposure. Also, in crewmen who did not take anti-motion sickness medication prior to splash-down, a brief period (8-24 hours) during which symptoms spontaneously occurred with head movements, preceeded the measured increase in tolerance to vestibular stress. In all cases, continued postflight

testing indicated that a return to approximate preflight levels of susceptibility to Coriolis motion sickness did eventually occur. A number of hypotheses have been advanced to explain the Skylab motion sickness findings, however, it is generally agreed that available data are inadequate to unequivocally define the mechanism or mechanisms underlying the changes which occurred.

Related to the above findings was the observation that all of the Skylab crewmen experienced a marked postflight deficit in postural stability. Quantitative measurements indicated that the change was most pronounced when the crewman was deprived of visual cues and was required to maintain a stable, upright posture solely on the basis of vestibular and tactile-kinesthetic sensory inputs. In all cases, complete recovery to preflight levels of postural equilibrium performance and locomotor ability occurred within approximately ten days after splashdown. It has been postulated that these changes were most likely the manifestation of alterations in the central nervous system integration of sensory inputs from the visual, vestibular, and tactile-kinesthetic sensory modalities which had occurred during the weightless space flight exposure. Measured alterations in neuro-muscular function, including the long loop myogenic reflex response, may also have contributed to the postflight changes observed in postural equilibrium.

In general, Skylab served to underscore that prolonged exposure to weightlessness can result in significant modifications in neuro-sensory and neuro-muscular function and cause highly undesirable responses such as the motion sickness syndrome. Data obtained from the Skylab neurophysiology

experiments, however, fell far short of providing explanations for the phenomena observed. It is recognized that much additional research using a variety of experimental approaches is needed to develop the information necessary to answer the questions raised by Skylab.

One such approach is the use of supine bedrest which many believe to represent a physiological analog of weightlessness. With this fact in mind the present study was designed to determine if the types of neuro-sensory and neuro-muscular alterations that were observed following the Skylab missions would also occur to some degree following exposure to prolonged supine bedrest.

PROCEDURES

Motion Sickness Susceptibility

This portion of the study utilized procedures and hardware identical to those developed for Skylab Experiment M131, Human Vestibular Function.

Approximately one week prior to the first pre-bedrest test each subject completed a standard motion experience questionnaire. This questionnaire provided needed information concerning the subject's motion sickness history, and was used to calculate the rotating chair velocity for his first test. Immediately prior to the first experimental session each subject was given verbal instructions on how to recognize and report his symptoms. During the test, the blindfolded subject was seated in the rotating chair device and rotated at the predetermined constant velocity. While rotating, the subject executed standardized head movement in the

four cardinal directions. These head movements were performed in sets, each set consisting of five head movements. Each set was separated by a 20 second period of no head movements. During the test, the subject was carefully monitored for signs and symptoms indicative of early motion sickness. The test was terminated when the subject manifested a low grade motion sickness (referred to a Malaise IIa) or after the performance of 150 head movements, which ever occurred first. The entire test procedure was typically completed in 20 minutes or less. Pre-bedrest data were obtained on each subject at F-30, F-15 and F-5. With exceptions noted under results, post-bedrest data were obtained at R+0, R+2 and R+7. This test was always performed following the daily completion of all other biomedical tests included in the bedrest study.

Postural Equilibrium

Postunal equilibrium was tested using a standard laboratory method developed for the Skylab flights.

The test employed a series of narrow metal rails on which the subject was required to maintain an upright posture with his feet tandomly aligned and arms folded across his chest. The rails were .75, 1.25, 1.75, and 2.25 inches wide. In addition, a tape served as the foot-guide alignment when the subject was required to stand on the floor. Each subject was fitted with military-type shoes for this test, to rule out differences in footwear as a variable. Performance on this task was measured under two sets of conditions. In the first, the subject was required to maintain postural equilibrium on the rail (or floor) with his eyes open. In the second condition, he attempted to balance

with his eyes closed. In both cases, performance was scored in terms of time (in seconds) on the rail before losing balance. On a given rail size, three test trials with a maximum required duration of 50 seconds each were allowed. If the time limit was reached in the first two trials, a third was not performed, and a perfect score of 100 seconds was recorded. If the subject failed to obtain a perfect score, the two largest time values for the three trials were summed to obtain the final score. During a test session, a minimum of two rail sizes were used in both the eyes open and eyes closed conditions. The total duration of this test did not exceed 20 minutes.

Electromyography (EMG)

Surface EMG activity was recorded using Beckman skin electrodes placed over the belly of the gastrocnemius muscle. Using an AC-DC preamplifier and amplifier, monosynaptic potential (MSP) and muscle stretch responses (MSR) were recorded from this electrode site. To obtain MSPs the subject was seated with the leg flexed at the knee, foot supported by the toes and the heel at a 90^0 angle with the floor. While in this position, 16 MSPs were elicited by tapping lightly with a hammer a thin bar placed over the appropriate tendon. The latency of the MSRs was obtained while the subject was seated with his foot restrained in a metal foot rest at a right angle to his leg. To elicit an involuntary MSR, the subject was asked to be prepared to resist any stretching force. Then, at random and unexpected times, manual force (a slap by the experimenter to the sole of the metal foot restraint) was suddenly applied and maintained by the experimenter to dorsiflex the foot. Voluntary response

times (MSR voluntary latency) was measured by requesting the subject to plantar-flex his foot as quickly as possible following a sharp, brief tap to the metal foot restraint. Sixteen involuntary and 16 voluntary MSR latencies were recorded.

The sharp sound (either hammer tap or slap) of the applied stimulus was used to indicate the onset of the stimulus and to trigger an oscilloscope on which the EMG response was displayed. Each separate response was photographed from the oscilloscope and both the stimulus trigger (microphonic pulse generated from the sound) and the response was recorded on a tape recorder for later analysis. The total time to record these data during a test session did not exceed 20 minutes. The combined EMG-postural equilibrium tests were run on each subject at F-30, F-15 and F-5 and again at R+0, R+2 and R+7. When the subjects arrived in the laboratory for the R+0 combined EMG-postural equilibrium tests, they were still supine and had not been upright (either sitting or standing) since the beginning of the 14-day bedrest period.

RESULTS

Motion Sickness Susceptibility

The pre- and post-bedrest results for this test are summarized in Table I. For each subject the chair speed (RPM) and number of head movements (HM) required to reach the Malaise IIa level of motion sickness are shown. The computed Coriolis Sickness Susceptibility Index (CSSI) is also given. Data for subjects 5 and 6 are missing on R+0 because at the scheduled time of the test, these subjects complained of symptoms which were very near or at the MIIa level of motion sickness and the test was, therefore, cancelled for that day.

Evaluation of the pre-bedrest data indicates that, with the exception of subject 4, all of the subjects were moderately to highly susceptible to Coriolis motion sickness. Subject 4 proved to be moderately insusceptible and indeed it was necessary to increase the chair speed on successive pre-bedrest tests days in order to achieve a level of vestibular stress that would result in the manifestation of symptoms. For purposes of comparison, it is significant to note that during preflight testing the typical Skylab astronaut rode the rotating chair at 20 RPM, performed 70 head movements and had a CSSI of 24.8.

When tested on R+0, all of the subjects showed slight to moderate increases in susceptibility relative to their pre-bedrest baselines. This change was most prominent in subject 4. As previously indicated, subjects 5 and 6 were excused from R+0 testing because of the presence of motion sickness type symptoms that developed gradually during the course of other R+0 biomedical test activities. Tests performed on R+2 yielded more variable results. Subjects 1 and 3 became slightly more susceptible than they had been on R+0. Subjects 2 and 5 showed levels of susceptibility approximately equal to their pre-bedrest levels. Subject 4 was still more susceptible than he had been pre-bedrest, but was improved relative to R+0, and subject 6 was less susceptible than he had been during any of the pre-bedrest tests. On R+7, subject 1 was approximately as susceptible and subjects 3 and 5 were slightly more susceptible than they had been preflight. Subjects 2, 4 and 6 on the other hand were less susceptible on R+7 than they had been pre-bedrest; a very marked increase in tolerance was demonstrated by subject 4.

Postural Equilibrium

Pre- and post-bedrest data obtained on each of the six subjects are presented in figures 1-6. In these figures eyes open and eyes closed postural equilibrium performance on each of the rail sizes used, plus the floor, is plotted as a function of test day.

The pre-bedrest data indicate that as a group, these subjects exhibited postural equilibrium performance equal to or better than the performance typically observed in previous populations, including the Skylab astronauts, tested by this method. Subjects 2 and 5, and to a slightly lesser extent subject 5, showed particularly outstanding rail balancing ability in both the eyes open and eyes closed conditions during the pre-bedrest tests. Also during the pre-bedrest period a majority of the subjects displayed continued improvement on this task indicating that learning was occurring.

When tested on R+0, four out of six subjects (2, 4, 5 and 6) demonstrated a slight overall deficit in both eyes open and eyes closed postural equilibrium performance relative to their pre-bedrest baseline performance. A slight eyes closed deficit was measured in subject 1 and no change was evident in subject 3 in either of the test conditions.

On R+2 subjects 1 and 6 continued to show a very slight deficit on only the eyes closed test condition and subject 4 demonstrated a slight deficit on only the eyes open condition. The remaining subjects had improved to levels of performance equal to or better than their pre-bedrest levels. The R+7 test revealed that rail balance performance met or exceeded pre-bedrest performance for all six subjects.

Aside from the lack of significant findings with the rail balancing test, all of the subjects did experience some ataxia during the first several hours after getting out of bed. This problem was particularly apparent when they attempted to walk around corners. Also, although it was not evident in their rail performance, several of the subjects reported that during the R+0 eyes closed test they were unable to sense small displacements of the head and body or make rapid postural adjustments. No spatial disorientation was reported; slight dizziness or vertigo during the rail test was reported by only two subjects (3 and 6). Recovery was rapid and no difficulties were reported during or following the R+2 test day.

Electromyography

Figure 7 illustrates the three different responses elicited from the subjects. The top 6 traces are representative of the monosynaptic potentials (MSP) which were obtained following a sharp tap to the Achilles tendon. The second set of 6 traces indicate the voluntary plantar-flexiation of the subject's foot in response to a sharp tap on the metal foot restraint. The third and last set of traces show an involuntary response. Note the similar latencies of the monosynaptic response in each condition. Note also the longer and more variable latency of the muscle stretch response (MSR) associated with the voluntary condition when it is compared with that of the involuntary response. These time relationships are representative of the 6 subjects tested.

Figure 8 indicates how the latency measurements were obtained for each condition. The time from stimulus onset to the MSP was taken

as the peripheral conduction time (PCT). Also measured from stimulus onset were the latencies of the MSRs. These MSR latencies are expressed as the functional stretch reflex time (FSR) for the involuntary response, and as the voluntary response time (VRT) for the voluntary response. Central conduction times (CCT) were calculated by measuring the time from the beginning of a MSP to the start of a MSR.

Figure 9-14 present latency measurements for all subjects during the 6 day test. Represented on the abscissa of each figure is test day. The same convention is used here as was employed to present test day in both the motion sickness susceptibility and postural equilibrium tests. Days F-30, F-15 and F-5 were pre-test measurements 30, 15 and 5 days prior to bedrest. Days R+0, R+2 and R+7 indicate post-test measurements. As previously noted on test day R+0, the subjects arrived in the laboratory in a supine position and were brought upright for the first time since the beginning of the 14-day bedrest period for these myographic measurements.

The data indicate that no major observable change is present in any of the latencies for the 6 subjects. The most consistant latency measured was the PCT which changed little within any one subject. The other latencies; VRT, FSR and CCT indicate some individual variation but were not influenced by the bedrest treatment.

Number of observations, means and the standard error of the mean as read from left to right in each row are presented in Table II for each subject and condition. Note that variability is low for the PCTs as well as the involuntary responses. As indicated in Figure 7, variability increases for the voluntary responses.

Amplitude measurements of the EMG were obtained in two ways. First, for the MSP, individual $N_1 - P_1$ amplitudes were calculated. Second, for the MSR of both the involuntary and voluntary responses, 16 trials for each test condition and each day were rectified, averaged and then integrated over time. Figures 15-20 represent $N_1 - P_1$ amplitudes in microvolts for all subjects during the 6 day test. Increases in $N_1 - P_1$ amplitudes are evident for the day on which the subjects ended the 14-day bedrest period for subjects 1, 2, 3, 4 and 5. No change was evident for subject 6. Note that this change in amplitude is for the most part considerably decreased by R+2. Table III presents the number of observations, means and standard error of the mean of $N_1 - P_1$ amplitudes for each subject in each condition. Note the low variability of this measurement within test day.

Figure 21 illustrates 16 rectified and averaged voluntary responses. Superimposed on the average is the integral of the 200 msec period. To determine the amplitude of the MSR only the integrated activity beginning 80 msec from stimulus onset to 180 msec is considered. This time is indicated by the two arrows. Figure 22 plots this value for each subject's voluntary and involuntary responses for each test day. Very little consistency is evident in these plots nor is the increased amplitude which was present in the $N_1 - P_1$ activity on R+0 indicated in the MSR.

DISCUSSION

Motion Sickness Susceptibility

The post-bedrest increases in susceptibility to Coriolis motion sickness observed in the present study were relatively small in magnitude

and short in duration. In this regard, these findings are somewhat reminescent of the temporary postflight increase in ssuceptibility to motion sickness observed in the Skylab 2 crewmen. In general, however, the post-bedrest tests did not yield results like those obtained following the Skylab missions. Most notably, the marked postflight decrease in susceptibility seen in the Skylab crewmen was not exhibited by the bedrest subjects.

These findings are not unexpected if one accepts the postulation that alterations in otolith function were primarily responsible for the postflight changes in the Skylab crewmen. In the absence of gravity, the otoliths, or the CNS integration of otolith generated sensory input, could be expected to undergo significant change. Such would not be the case in individuals bed-rested in a 1-g environment.

To conclude at this time, however, that supine bedrest does not result in sensory physiological alterations like those produced by prolonged exposure to weightless space flight would be premature. The reasons are several. First, the Skylab missions ranged from 28 to 84 days in duration, whereas, the exposure to supine bedrest was only 14-days in duration. It is conceivable that 28 days or longer supine bedrest might result in alterations more analogous to those seen following Skylab. Secondly, because of the potential significance of the fluid shifts involved, the effects of weightlessness might be better simulated by head-down tilt bedrest rather than supine bedrest. Such a study has yet to be done. Finally, the Skylab crews had periodic exposure to the rotating chair test, as well as other vestibular stimulation, and therefore, had more opportunity to acquire habituation to stressful cross-coupled

angular acceleration. The bedrest subjects had no such opportunities; this could in part explain their increased susceptibility post-bedrest or at least explain their lack of decreased susceptibility.

Aside from comparisons with the Skylab data, one other factor is worthy of consideration which may in part account for the higher than average motion sickness susceptiblity demonstration by the bedrest subjects. All pre- and post-bedrest motion sickness tests were preceeded by the Skylab M171 exercise tolerance test. Although the subjects were given an opportunity to rest and never manifested overt symptoms of fatigue, it is conceivable that the stressful exercise test did lower their threshold to motion sickness. In future studies of this type, an attempt should be made to avoid scheduling any stressful tests prior to motion sickness susceptibility testing.

Finally, in considering the significance of the subjects' post-bedrest responses a distinction must be made between symptoms of motion sickness having their etiology in the vestibular system and symptoms characteristic of motion sickness, but not of vestibular origin. That is, the symptoms experienced by two of the subjects which prevented their being tested on R+0 were probably not the result of vestibular hypersensitivity, but instead the result of a generalized autonomic nervous system response to the various physical stresses encountered during the first hours after termination of bedrest.

Postural Equilibrium

The static rail balancing test procedure employed in the present study revealed short-lived and functionally insignificant changes in

post-bedrest postural equlibrium performance. As might be expected from previous test situations, where change were detected they tended to be greater when the subject was deprived of visual cues.

No firm conclusions regarding the comparability of supine bedrest and weightlessness in producing sensory system modification can be drawn from the present study. This is true largely because of the significantly longer duration of the Skylab missions from which data are available. Fourteen days supine bedrest may be insufficient time for the sensory and particularly neuro-muscular system alterations presumed responsible for the Skylab postflight postural disturbances to occur. It must also be recognized, however, that sensory system modification during bedrest would include little if any otolithic contribution regardless of the duration of bedrest. Assuming this to be true, the total patterning of sensory system modification should be different for periods of exposure to bedrest and weightlessness of equal duration. Therefore, even if equal periods of bedrest and weightlessness produced highly similar changes in postural responses the underlying causes could be quite different.

As noted, all of the subjects in this study did exhibit ataxia on R+0 even though rail performance was good. This finding suggests that the rail test may have been insensitive to a change that was present. Indeed, in a 14-day bedrest study conducted at the Ames Research Center a battery of 11 body balance tests were used and only two, a rail walk (eyes open) and one-leg rail balance (eyes open), revealed a post-bedrest deficit in balancing performance. These combined finding indicate that

future bedrest tests should utilize dynamic balancing (e.g., walking) tests in addition to static tests of the type used in the present study.

Electromyography

The results of this investigation indicate that some change in the amplitude of the evoked monosynaptic potential was present following 14 days of bedrest. The amplitude change by itself does not, however, reflect completely those changes observed following the Skylab missions.

Long term space flight and exposure to prolonged periods of weightlessness, as experienced during Skylab, tend to generate a hyperreflexia. Both an increase in the Achilles tendon reflex amplitude and an increased gastrocnemis muscle potential as well as a decrease in the reflex reaction time have been reported. These changes when observed together with an increase in postural instability support a concept which suggests that central neural reorganization occurs in response to environmental change. Specifically, a central nervous system "pattern center" concept could be postulated to help understand the mechanism encountered in the adaptation process. For example, following insertion into orbit, the crewmen may experience difficulty in maneuvering and find orientation to be a problem. Shortly, however, movement from one area of the vehicle to another would become somewhat easier. Fine motor control to determine displacement would be established. Adaptation in the neuromuscular system would have occurred.

Once an adequate memory of the required pattern is established, the "pattern center" would take over muscular control on an involuntary basis. Return to a 1-g environment would result in a recurrence of the

learning process. Habituation to a gravity reference would begin almost immediately and a new effective pattern in the "pattern center" would be established. Part of this habituation processes would be reflected in the observed postflight hyperreflex activity.

If, as the Skylab results suggest, an environment dependent memory store (pattern center) of frequently repeated sensory inputs is operative which registers the actual movement and allows for anticipation and compensation of each movement as it occurs is accepted; then it is reasonable not to observe both amplitude and latency changes in neuromuscular activity following bedrest. Specifically, in a 1-g environment, it is not anticipated that new muscle responses need to be generated during bedrest. Instead, it is more likely that those responses which serve us while standing and walking in a 1-g environment will continue to operate during prolonged periods of bedrest.

Bedrest must, however, introduce some neuromuscular changes because of the relative inactivity imposed in this condition. During a short period such as this 14 day test one of the major changes could be observed in the transmitter substances found in the synaptic cytoplasm. For example, it is possible that during bedrest, levels of norepinephrin could drop. When the subjects are raised from a supine position these levels could increase significantly and be reflected in the increased amplitude of the monosynaptic muscle potentials. At this time, a complete urine analysis is not available. Once this has been completed, this hypothesis can be evaluated.

In summary, our findings do not at this time indicate that

ordinary bedrest can adequately simulate prolonged exposure to weightlessness. However, this conclusion is only tenative. Further experimentation would be valuable.

TEST DAY	SUBJECTS																	
	1			2			3			4			5			6		
	RPM	HM	CSSI	RPM	HM	CSSI	RPM	HM	CSSI	PRM	HM	CSSI	RPM	HM	CSSI	RPM	HM	CSSI
F-30	7.5	60	3.8	10	20	2.1	7.5	35	2.2	7.5	150	>9.8	7.5	20	1.3	5	45	1.4
F-15	7.5	45	2.9	7.5	40	2.6	7.5	55	3.5	12.5	150	>22.5	5	75	2.4	5	55	1.8
F-5	7.5	40	2.6	7.5	35	2.2	7.5	50	3.2	20	70	23.1	5	35	1.1	5	70	2.2
R+0	7.5	40	2.6	7.5	25	1.6	7.5	35	2.2	20	30	9.9	-	-	-	-	-	-
R+2	7.5	35	2.2	7.5	30	1.9	7.5	25	1.6	20	45	14.9	5	50	1.6	5	105	3.4
R+7	7.5	55	3.5	7.5	55	3.5	7.5	35	2.2	20	140	45.2	5	25	0.8	7.5	55	3.5

TABLE I.

Pre- and post-bedrest motion sickness susceptibility test results. For each subject, the chair speed (RPM) and number of head movements (HM) required to reach the Malaise IIa level of motion sickness are shown. The computed Coriolis Sickness Susceptibility Index (CSSI) is also given.

	RESPONSE	SUBJECT	TEST DAY F-30	F-15	F-5	R+0	R+2	R+7
PET	ACHILLES TENDON REFLEX	1	12, 33.8, 0.17	12, 34, 0	12, 34, 0.19	18, 34, 0.11	18, 33, 0.60	18, 33, 0.19
		2	12, 37, 0	12, 36, 0	12, 36, 0	18, 39, 0.16	18, 39, 0.09	18, 38, 0
		3	12, 37.8, 0.19	16, 37, 0	12, 37, 0	18, 40, 0.12	18, 39, 0	18, 37, 0.11
		4	12, 33.5, 0.19	12, 34, 0	12, 34, 0	18, 36, 0.12	18, 34, 0.11	18, 34, 0
		5	12, 32, 0.19	12, 34, 0	12, 33, 0	18, 34, 0	18, 34, 0.34	18, 34, 0.12
		6	12, 34.5, 0.15	12, 35, 0.25	12, 34, 0	18, 35, 0	18, 35, 0.11	18, 35, 0
	VOLUNTARY	1	12, 34, 0	12, 35, 0	12, 35, 0	12, 35, 0	18, 35, 0.12	18, 34, 0.06
		2	10, 42, 0.36	12, 39, 0.30	14, 38, 0	18, 39, 0.08	18, 40, 0.12	18, 40, 0.20
		3	12, 39, 0.62	12, 38, 0.42	12, 36, 0	18, 39, 0.14	18, 36, 0.11	18, 37, 0
		4	12, 34.3, 0.22	16, 34, 0	12, 34, 0	18, 35, 0	18, 35, 0	18, 35, 0.11
		5	12, 34.5, 0.38	12, 34, 0	13, 35, 0.21	18, 35, 0	18, 34, 0.11	18, 33, 0.11
		6	12, 40.3, 2.29	16, 35, 0.13	12, 35, 0	17, 36, 0.59	17, 36, 0.11	16, 35, 0
	INVOLUNTARY	1	12, 32.9, 0.08	16, 34, 0.09	15, 34, 0	18, 35, 0	18, 34, 0.11	18, 34, 0
		2	11, 36, 0.24	16, 37, 0.13	15, 38, 0.12	18, 39, 0.14	18, 38, 0	18, 38, 0.16
		3	12, 37, 0.39	12, 36, 0	12, 36, 0	18, 37, 0.12	18, 36, 0	18, 36, 0
		4	15, 32.5, 0.13	12, 33, 0	12, 33, 0.15	18, 35, 0	18, 35, 0.15	17, 33, 0.12
		5	12, 32, 0	12, 34, 0	12, 34, 0.30	18, 34, 0	18, 39, 0.11	18, 33, 0
		6	11, 34.8, 0.16	12, 35, 0	12, 35, 0	18, 35, 0	18, 35, 0	18, 35, 0.08
CCT	VOLUNTARY	1	12, 106, 3.23	12, 106, 4.19	12, 104, 3.07	17, 95, 2.70	18, 101, 2.32	18, 97, 1.30
		2	10, 100, 5.82	12, 82.8, 4.01	14, 85, 5.70	18, 80, 2.60	18, 86, 4.16	18, 80, 4.24
		3	12, 102, 4.75	12, 84, 3.49	12, 88, 4.13	18, 69, 3.58	18, 84, 3.58	18, 79, 3.35
		4	12, 92, 6.50	16, 98, 4.78	12, 83, 4.20	18, 87, 1.35	18, 69, 2.13	18, 79, 1.83
		5	12, 100, 4.92	12, 98, 3.86	13, 103, 3.75	18, 95, 3.14	13, 83, 2.50	18, 90, 2.22
		6	12, 74.2, 3.49	16, 87, 4.46	12, 94, 4.42	17, 67, 2.28	17, 78, 4.79	16, 81, 3.07
	INVOLUNTARY	1	12, 92.5, 1.69	16, 98, 2.21	15, 96, 2.09	18, 92, 1.42	18, 105, 3.15	18, 92, 1.99
		2	11, 56, 1.47	16, 65, 2.79	15, 59, 1.36	18, 65, 2.09	18, 59, 1.86	18, 80, 2.95
		3	12, 80.4, 4.27	12, 70, 3.12	12, 75, 2.13	18, 69, 1.93	18, 72, 1.77	18, 71, 2.55
		4	15, 78.5, 3.07	12, 74, 3.33	12, 70, 1.63	18, 73, 2.27	18, 70, 2.26	17, 65, 2.15
		5	12, 89.9, 3.74	12, 74, 1.51	12, 80, 2.51	18, 76, 1.60	18, 71, 1.45	18, 70, 1.33
		6	11, 56.5, 1.63	12, 59, 1.04	12, 66, 2.65	18, 56, 2.50	18, 55, 1.37	18, 54, 1.06
VRT	VOLUNTARY	1	12, 140, 3.28	12, 141, 4.19	12, 139, 3.07	17, 130, 2.71	18, 136, 2.34	18, 131, 1.82
		2	10, 142.5, 5.80	12, 122, 4.01	14, 123, 5.70	18, 119, 2.60	18, 125, 4.18	18, 120, 4.13
		3	12, 141, 4.79	12, 123, 3.50	12, 121, 4.13	18, 127, 3.61	18, 120, 3.55	18, 116, 3.35
		4	12, 126, 6.53	16, 132, 4.78	12, 122, 4.20	18, 122, 1.35	18, 124, 2.13	18, 115, 1.99
		5	12, 135, 4.85	12, 132, 3.86	13, 138, 3.75	18, 130, 3.14	18, 123, 2.40	18, 124, 2.21
		6	12, 115, 3.65	16, 122, 4.47	12, 129, 4.42	17, 103, 2.29	17, 114, 4.80	16, 116, 3.07
FSR	INVOLUNTARY	1	12, 125.4, 1.73	16, 132, 2.18	15, 130, 2.09	18, 127, 1.42	18, 139, 3.13	18, 126, 1.99
		2	11, 92.7, 1.41	16, 102, 2.74	15, 97, 1.34	18, 104, 2.10	18, 97, 1.86	18, 118, 3.05
		3	12, 116, 3.81	12, 105, 2.67	12, 111, 2.13	18, 106, 4.94	18, 108, 1.77	18, 107, 2.55
		4	15, 110, 3.04	12, 107, 3.33	12, 103, 1.66	18, 108, 2.27	18, 105, 2.16	17, 98, 2.17
		5	12, 121.9, 3.74	12, 108, 1.51	12, 113, 2.44	18, 109, 1.55	18, 105, 1.40	18, 108, 1.39
		6	11, 90.9, 1.67	12, 94, 1.04	12, 101, 2.65	18, 91, 2.50	18, 90, 1.37	18, 89, 1.06

Table II.

Number of observations, means, and the standard error of the mean read from left to right in each row for each subject in every condition. Test day is presented in the 6 columes. The means presented in this table were used to construct Figure 9-14.

TABLE III.

	RESPONSE	SUBJECT	TEST DAY F-30	F-15	F-5	R+0	R+2	R+7
$N_1 - P_1$ AMPLITUDE	ACHILLES TENDON REFLEX	1	12, 107, .003	12, 121, .004	12, 112, .005	18, 239, .008	18, 91, .002	18, 136, .003
		2	12, 29.8, .002	12, 47.7, .004	12, 38, .003	18, 88, .003	18, 56, .003	18, 53, .004
		3	12, 49, .006	16, 53, .007	12, 43, .004	18, 128, .008	18, 101, .005	18, 96, .003
		4	12, 119.5, .009	12, 116, .007	12, 86, .009	18, 31, .012	18, 95, .005	18, 183, .011
		5	12, 120, .003	12, 119, .004	12, 116, .009	18, 204, .010	18, 89, .004	18, 99, .003
		6	12, 56, .006	12, 33, .002	12, 50, .003	18, 42, .002	18, 46, .003	18, 72, .004
	VOLUNTARY	1	12, 121, .003	12, 106, .005	12, 99, .003	17, 194, .005	18, 106, .003	18, 120, .003
		2	10, 6.8, .001	12, 29.6, .004	14, 28, .002	18, 69, .004	18, 39, .003	18, 48, .003
		3	12, 21.5, .003	12, 29, .004	12, 24, .001	18, 123, .009	18, 45, .003	18, 46, .003
		4	12, 93.4, .009	12, 68.6, .006	12, 102, .001	18, 282, .010	18, 89, .005	18, 180, .010
		5	12, 48, .007	12, 90, .005	13, 45, .005	18, 156, .008	18, 97, .006	18, 99, .005
		6	12, 14.7, .003	16, 14, .003	12, 30, .003	17, 22, .003	17, 28, .003	16, 32, .003
	INVOLUNTARY	1	12, 99, .002	16, 102, .004	15, 97, .004	18, 151, .005	18, 96, .003	18, 90, .003
		2	11, 60, .003	16, 69, .002	15, 56, .002	18, 97, .004	18, 85, .004	18, 65, .004
		3	12, 41, .006	12, 104, .007	12, 49, .002	18, 141, .005	18, 68, .002	18, 71, .002
		4	15, 214, .009	12, 158, .007	12, 206, .009	18, 403, .010	18, 174, .009	18, 226, .015
		5	12, 196, .011	12, 147, .005	12, 102, .010	18, 245, .010	18, 106, .005	18, 119, .003
		6	11, 97, .004	12, 49, .004	12, 56, .003	18, 41, .003	18, 50, .002	18, 74, .004

Number of observations, means and the standard error of the mean read from left to right in each row for each subject in every condition. Test day is presented in the 6 columes. The means presented in this table were used to construct Figure 15-20.

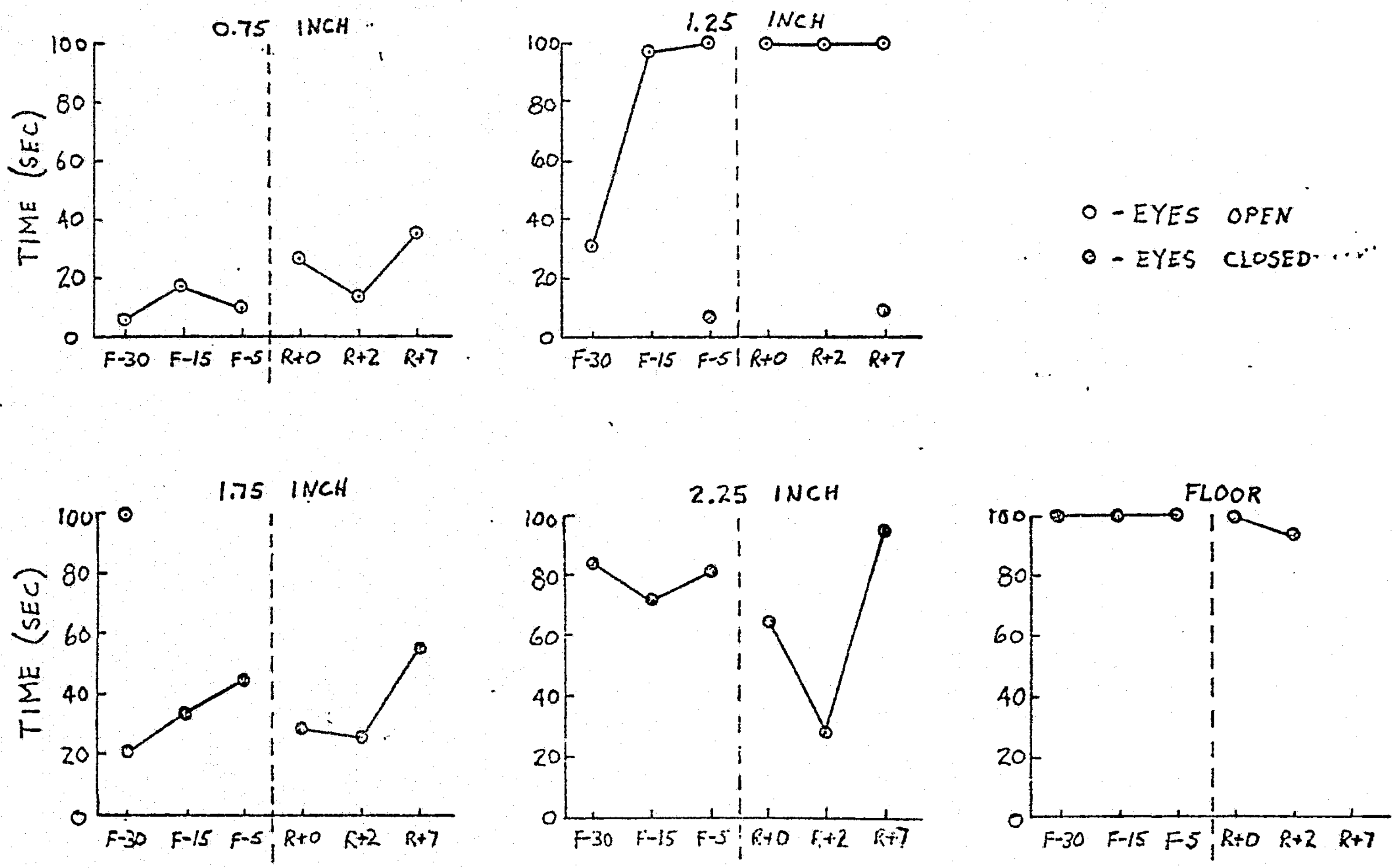

Figure 1. Pre- and post-bedrest postural equilibrium performance for subject 1.

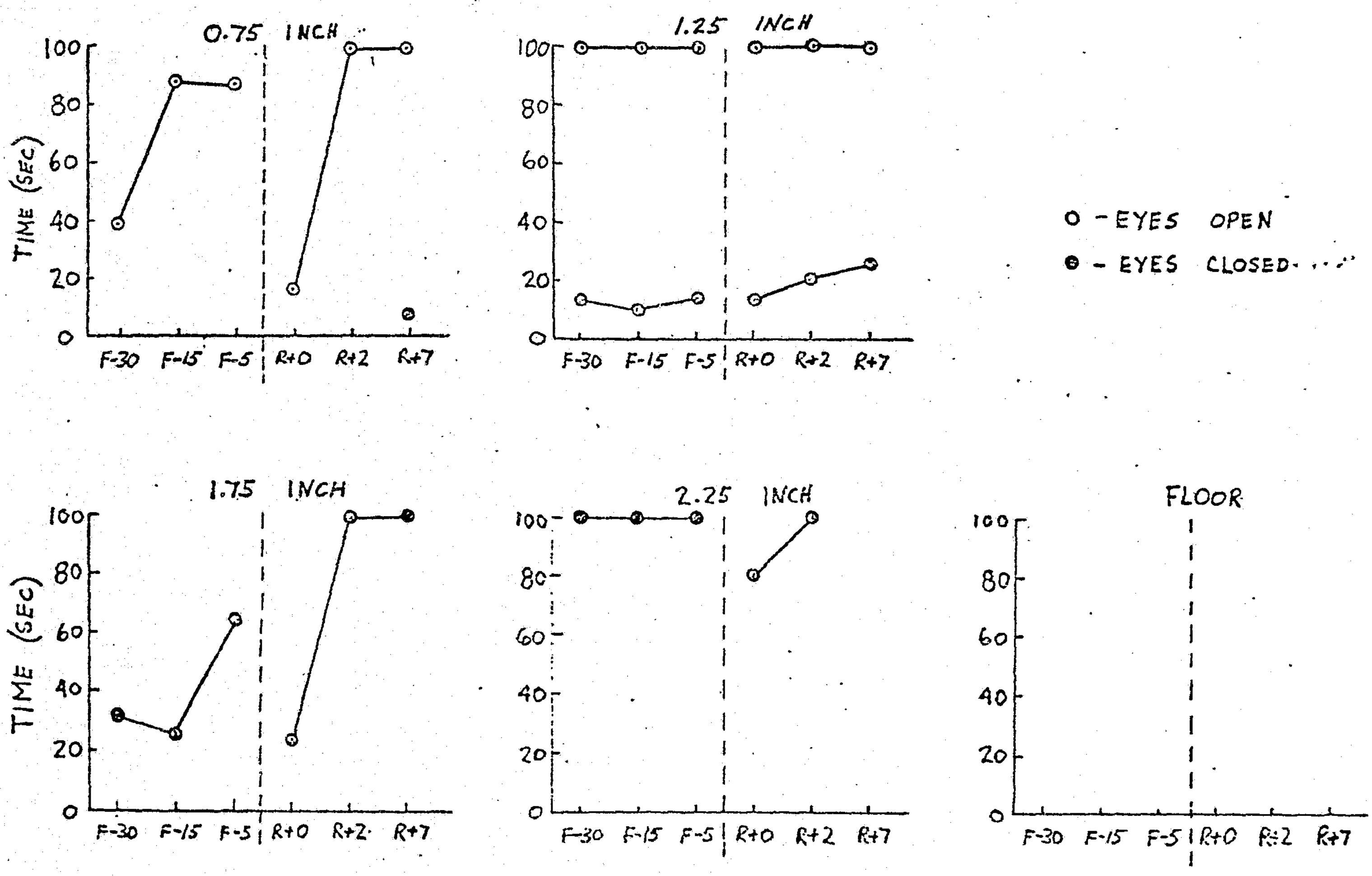

Figure 2. Pre- and post-bedrest postural equilibrium performance for subject 2.

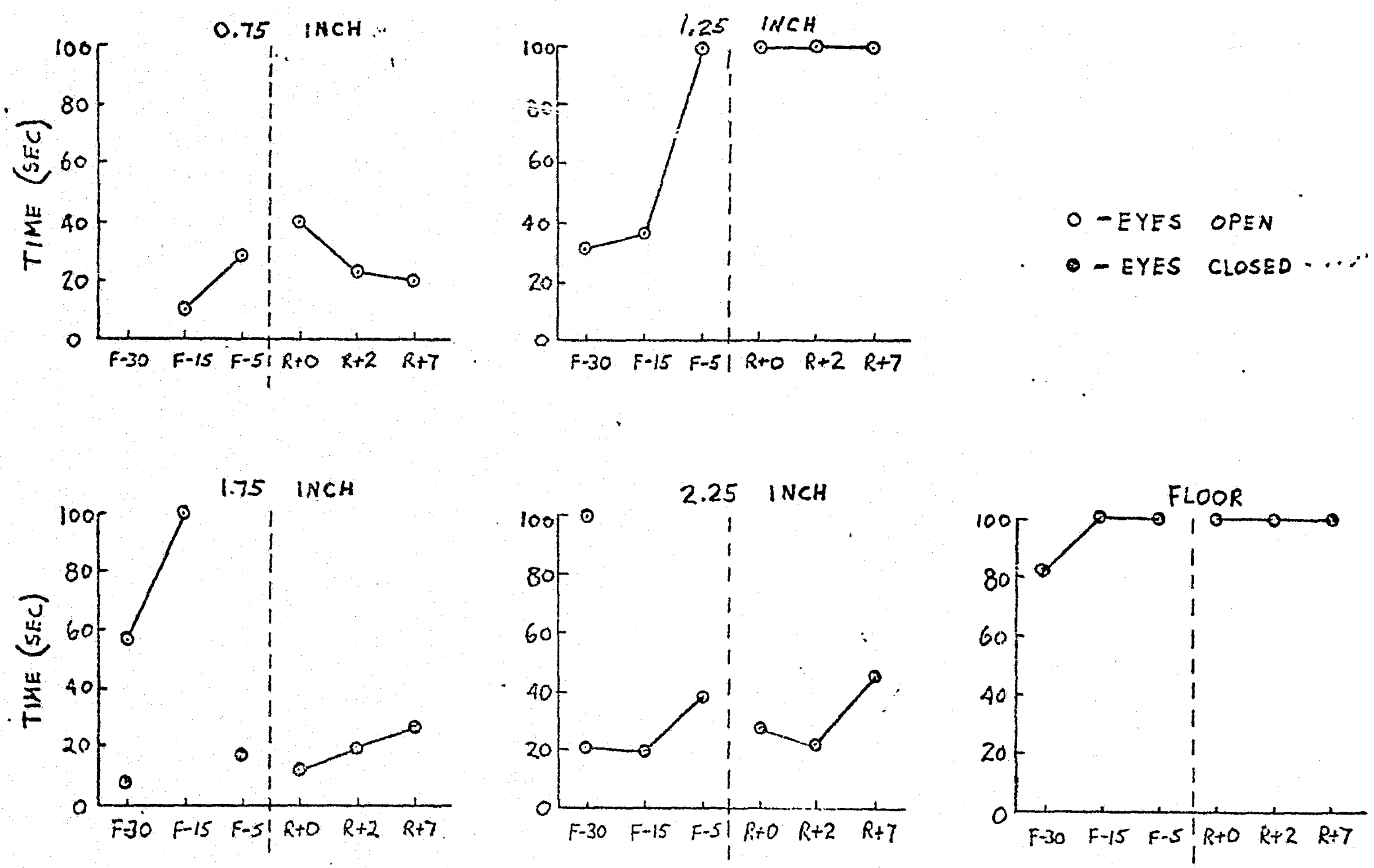

Figure 3. Pre- and post-bedrest postural equilibrium performance for subject 3.

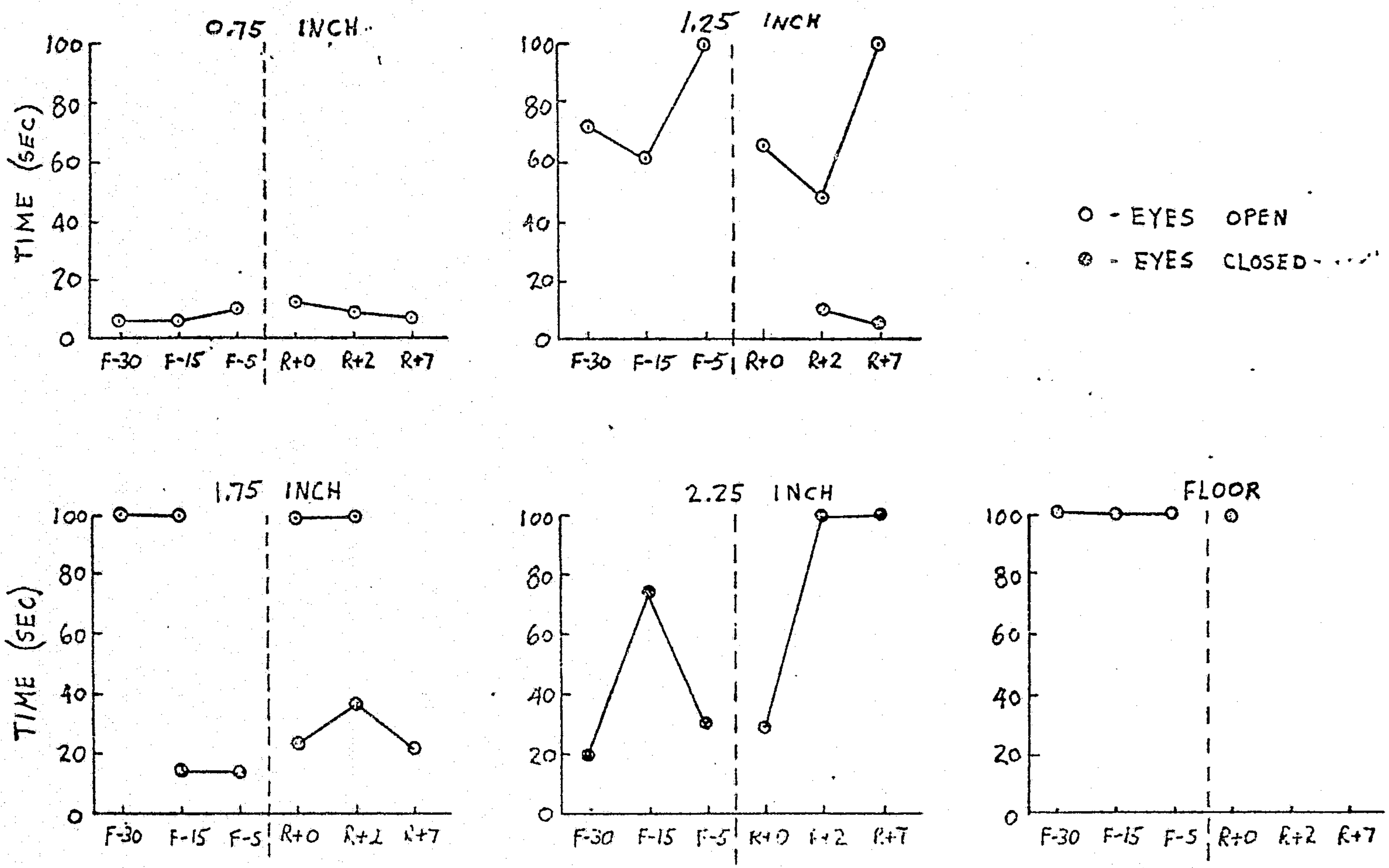

Figure 4. Pre- and post-bedrest postural equilibrium performance for subject 4.

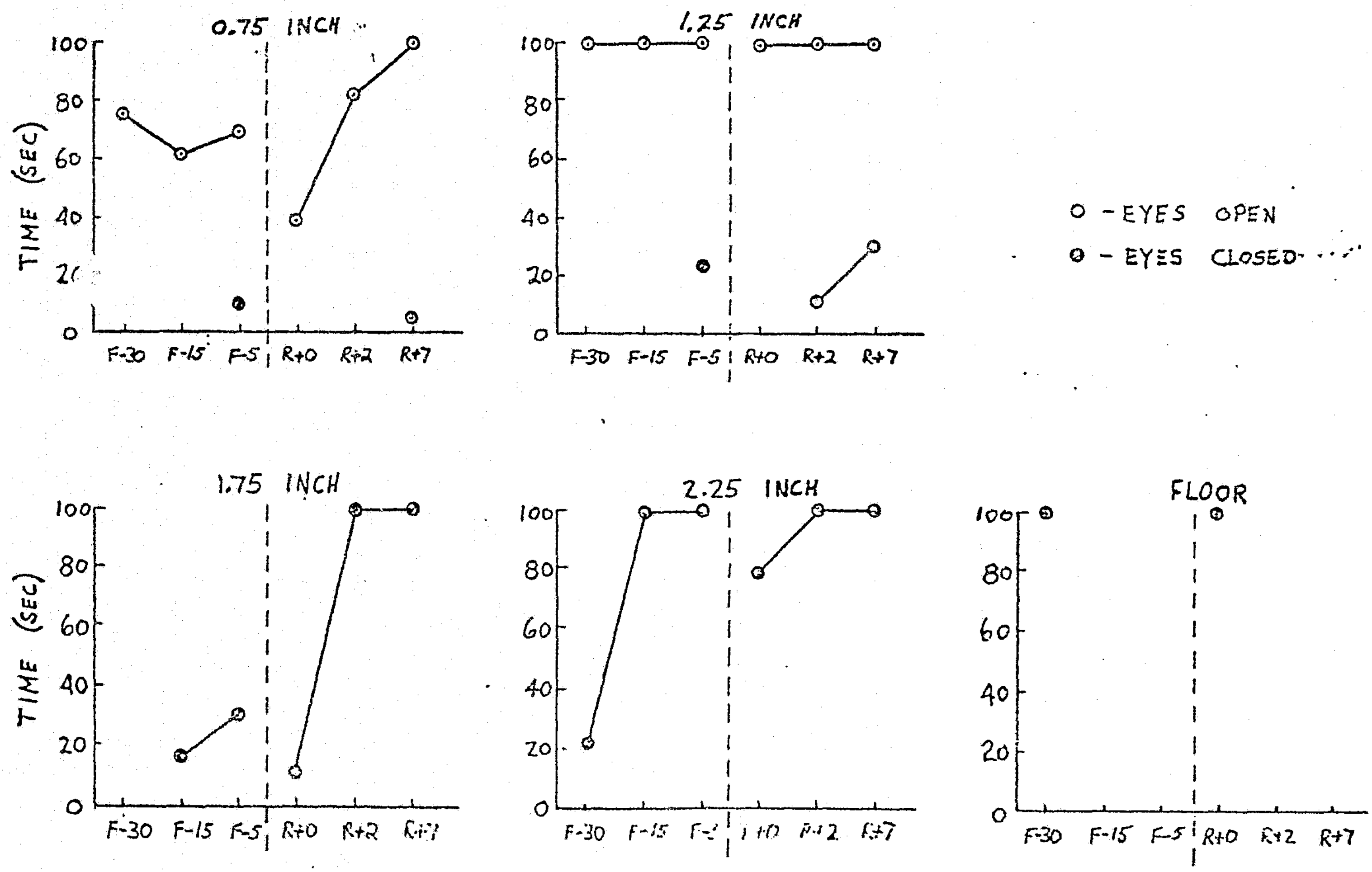

Figure 5. Pre- and post-bedrest postural equilibrium performance for subject 5.

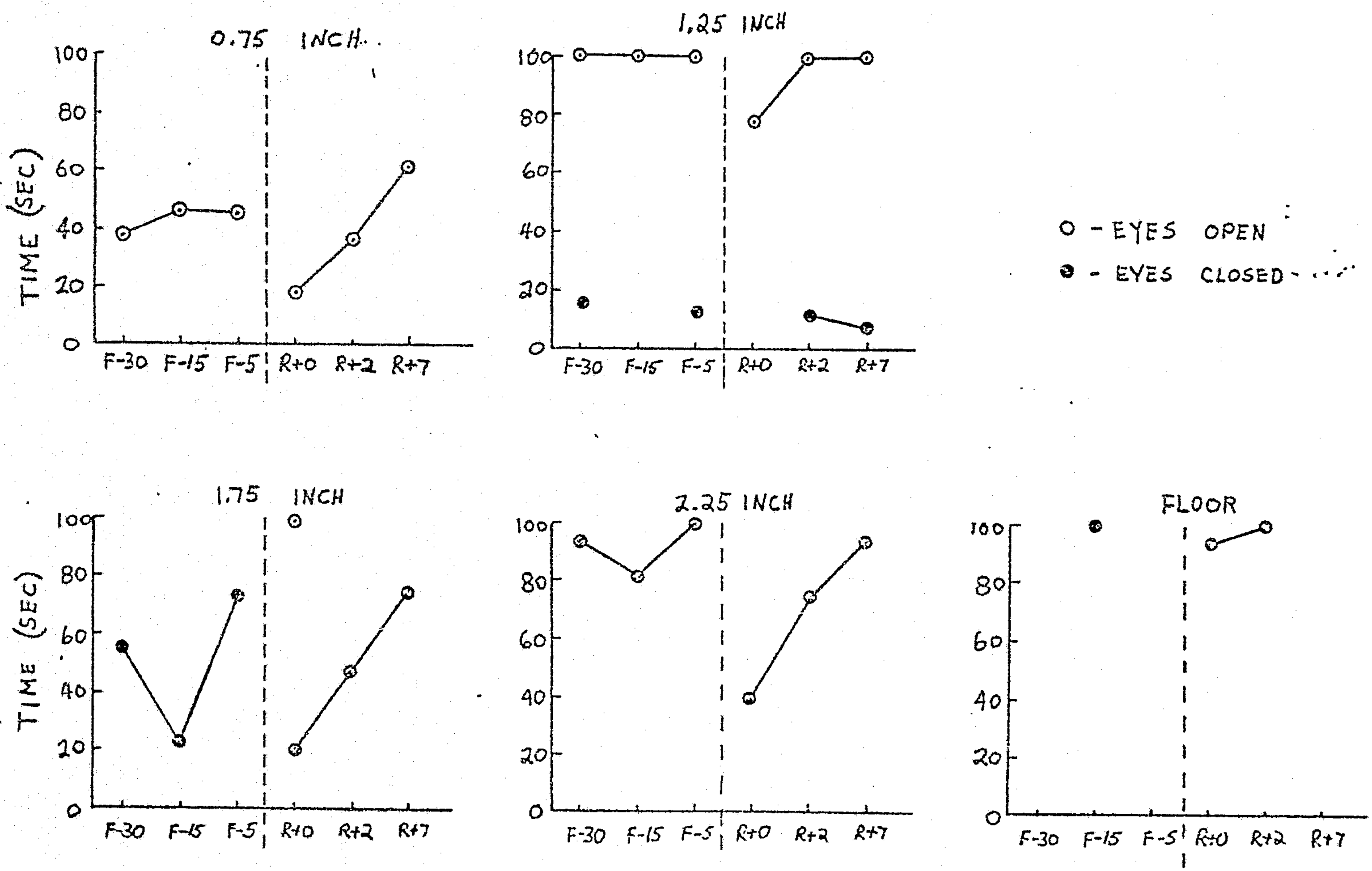

Figure 6. Pre- and post-bedrest postural equilibrium performance for subject 6.

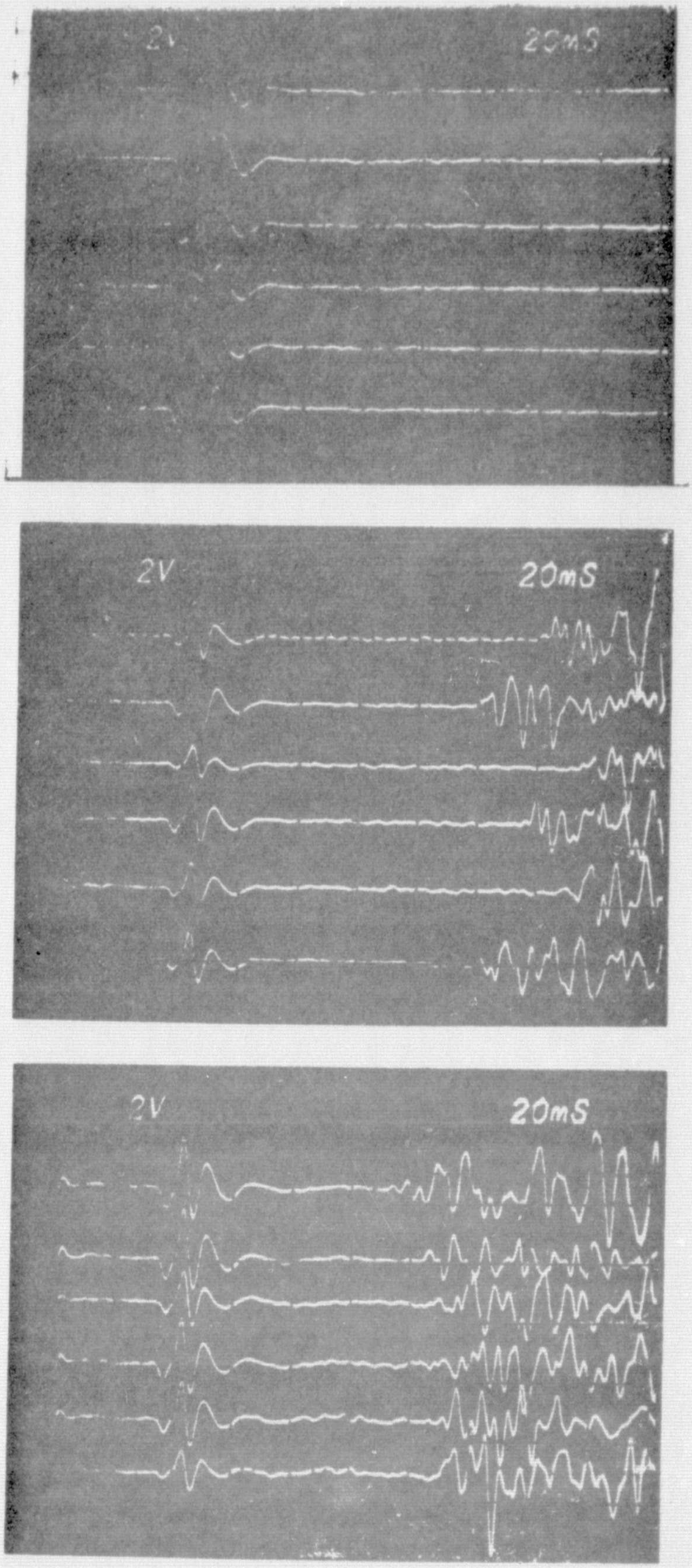

Figure 7. Monosynaptic potentials, voluntary responses and involuntary responses. Total sweep time as indicated is 200 msec with 2V per division equal to 1mv.

Figure 8.

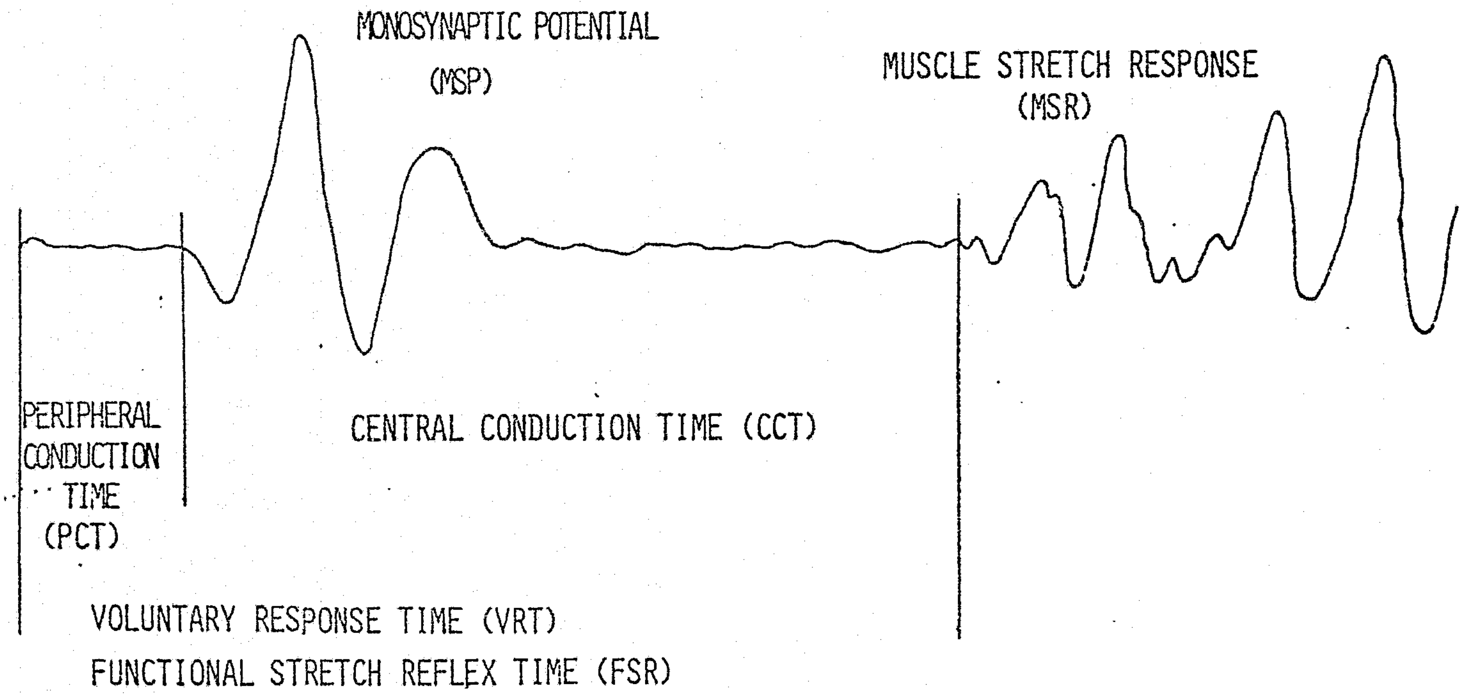

Figure 8. Peripheral conduction time (PCT) is measured from the time of stimulus onset to the beginning of the monosynaptic potential (MSP). Also measured from the time of stimulus onset are the voluntary response time (VRT) and functional stretch reflex time (FSR). The response interval noted as central conduction time (CCT) was measured from the start of the MSP to the start of the muscle stretch response (MSR).

Figure 9.

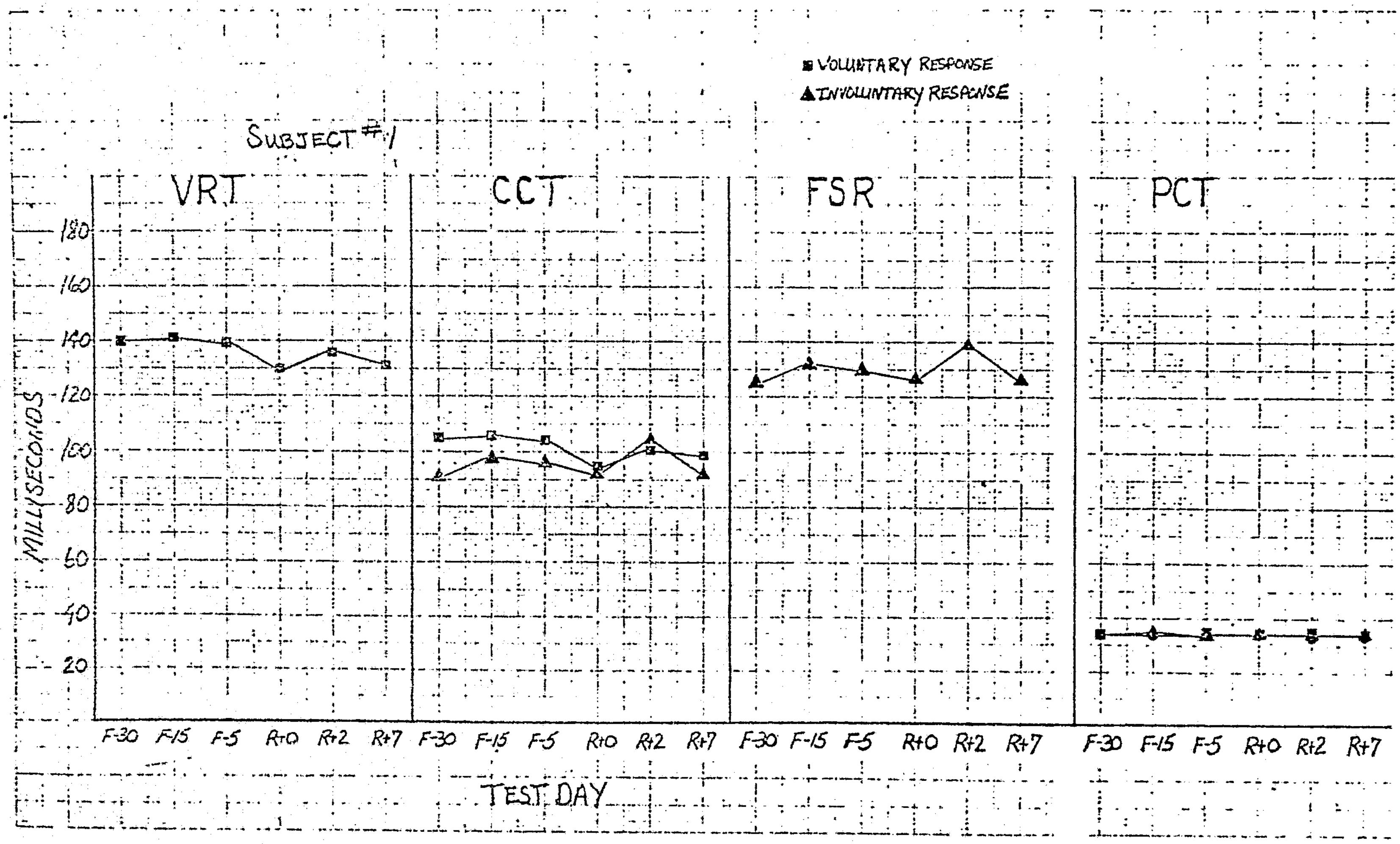

Figure 9. Response times obtained for subject 1. Test day is represented on the abscissa for each condition (VRT, CCT, FSR, PCT). Latency measurements in msec are located on the ordinate for the VRT, FSR and PCT conditions. The ordinate for CCT represents time delays of the MSR occurring within the central nervous system. Note that the CCTs were obtained for both voluntary and involuntary conditions. Also note that tendon reflex times along with voluntay and involuntary response times were included in the PCT measurements.

Figure 10.

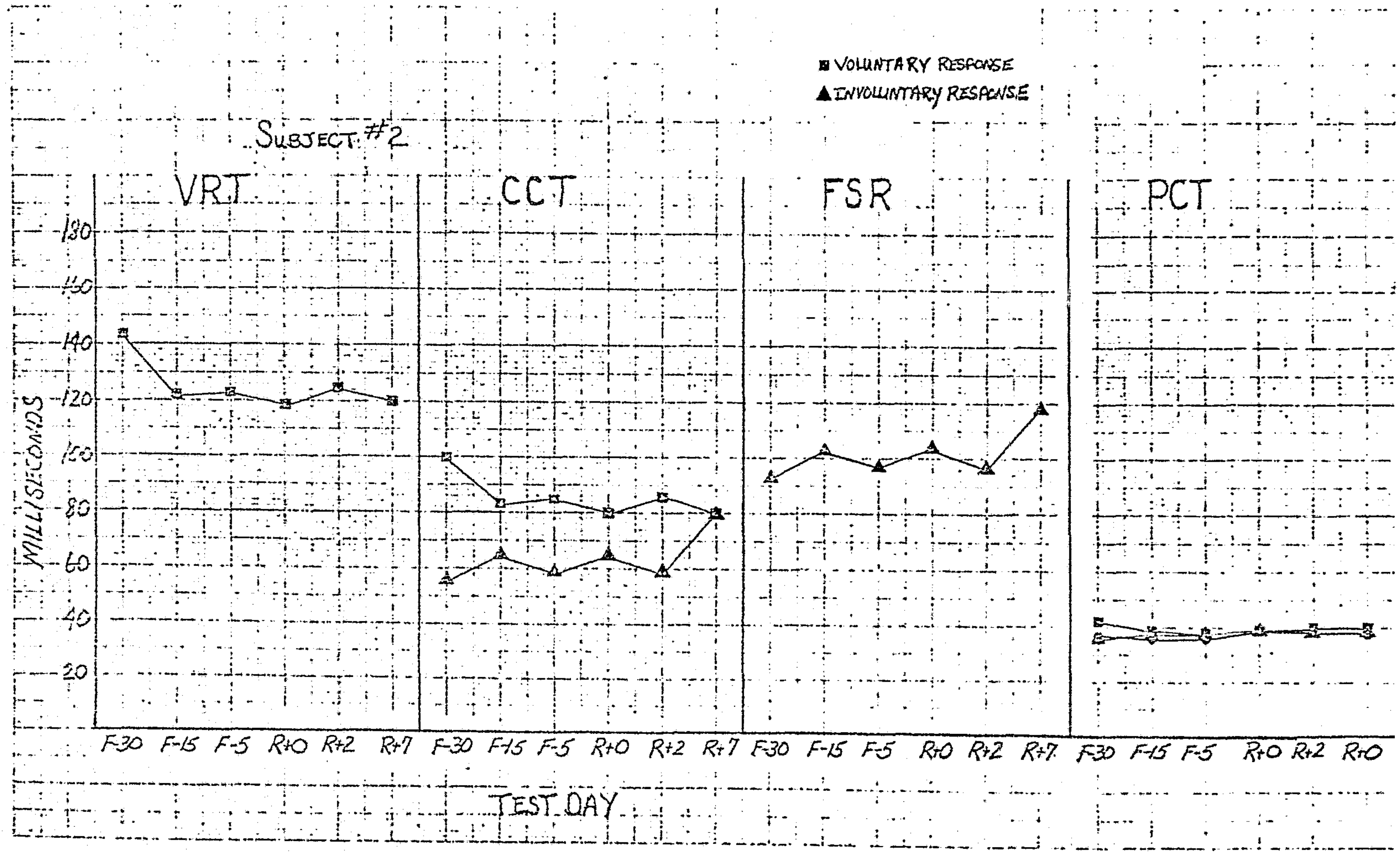

Figure 10. Response time obtained for subject 2. Conventions are those given for Figure 9.

Figure 11.

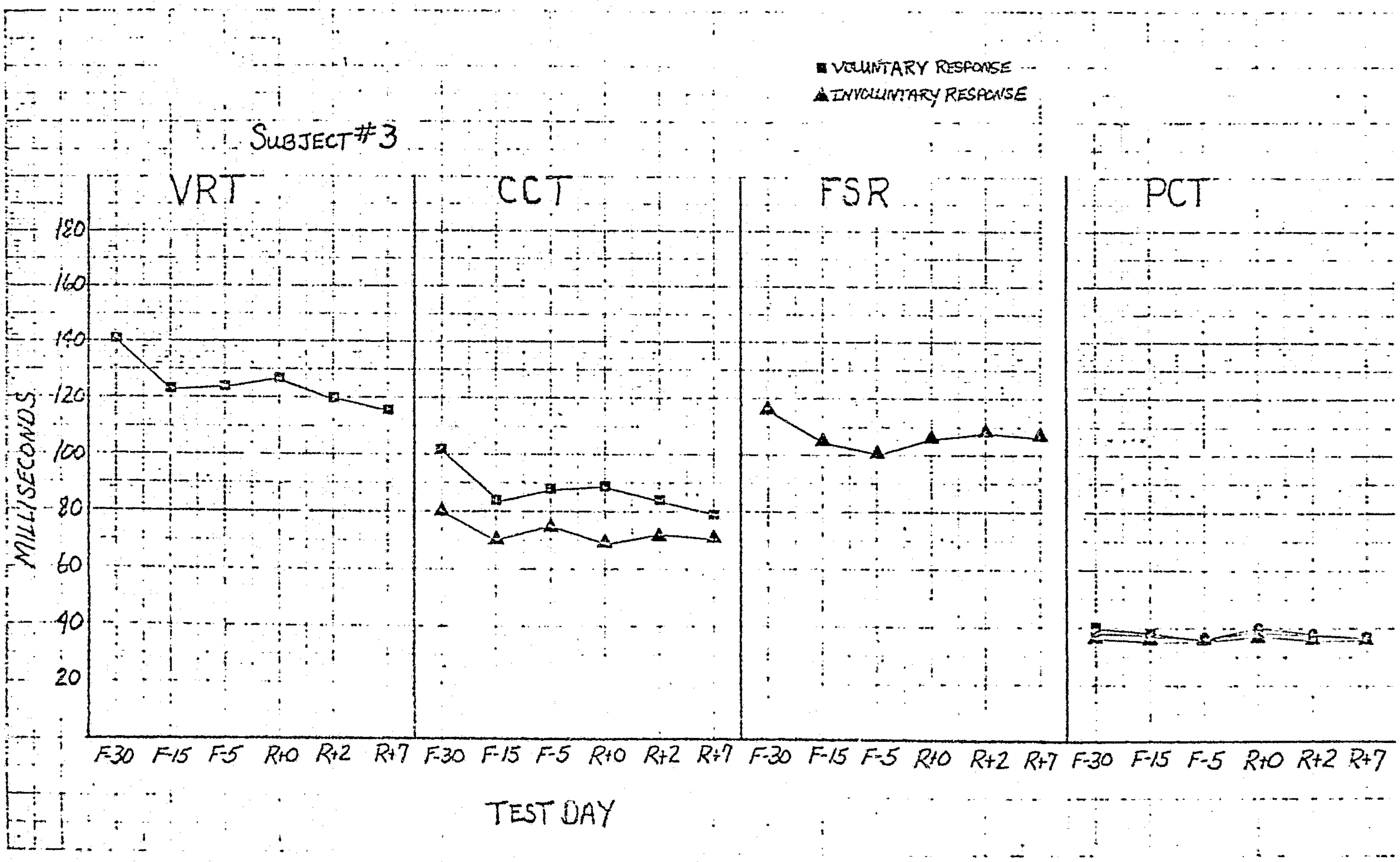

Figure 11. Response times obtained for subject 3. Conventions are those given for Figure 9.

Figure 12.

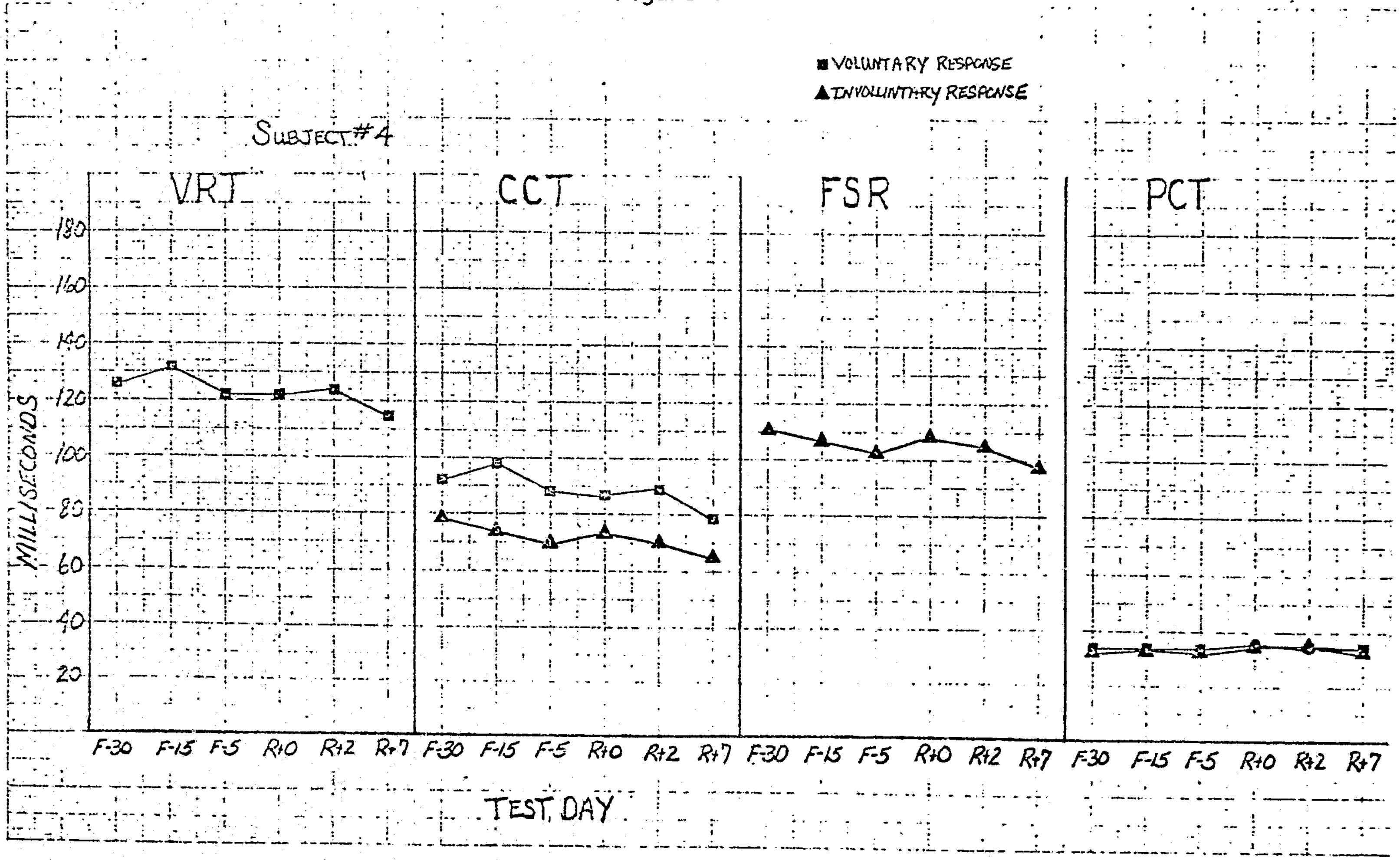

Figure 12. Response times obtained for subject 4. Conventions are those given for Figure 9.

Figure 13.

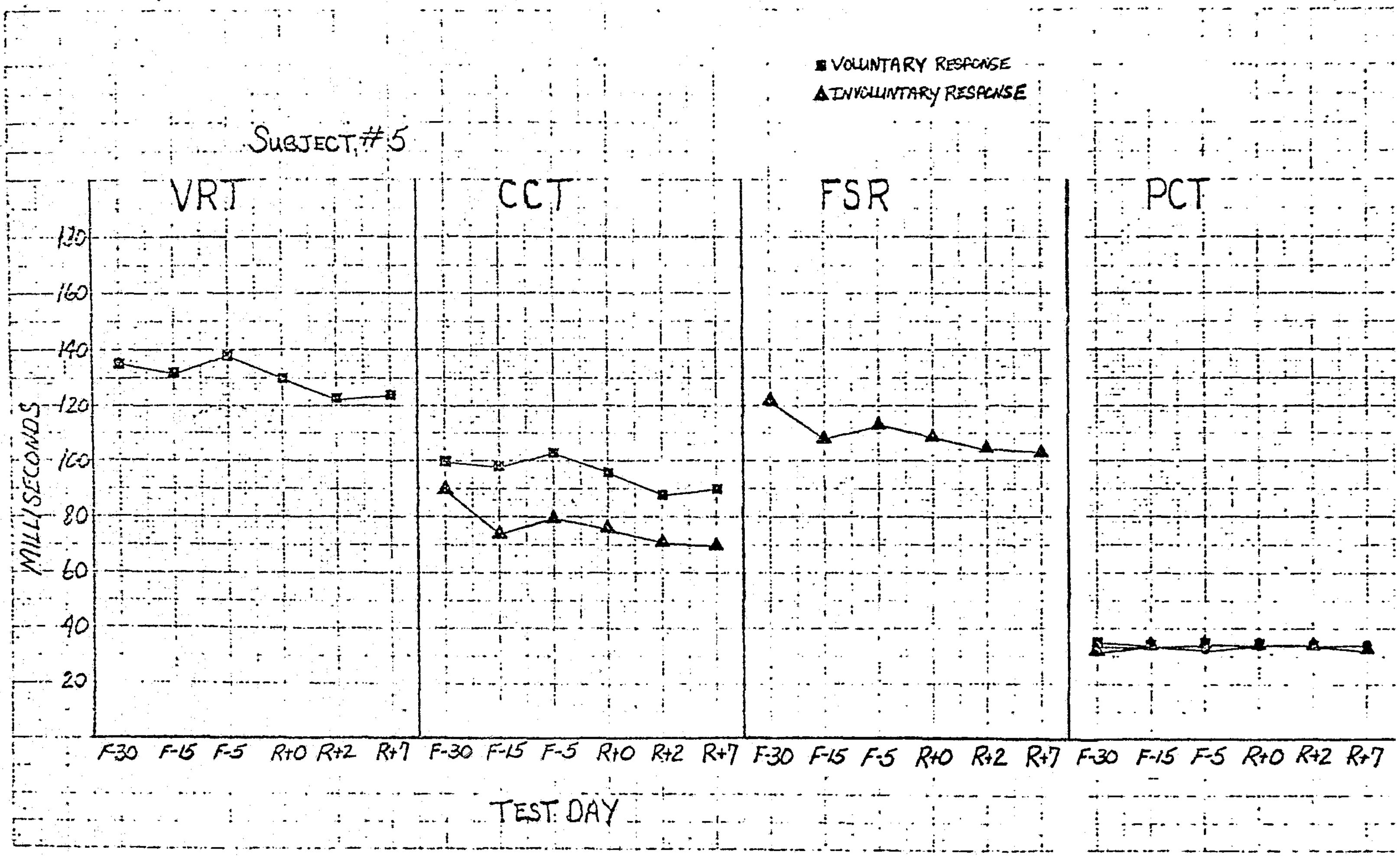

Figure 13. Response times obtained for subject 5. Conventions are those given for Figure 9.

Figure 14.

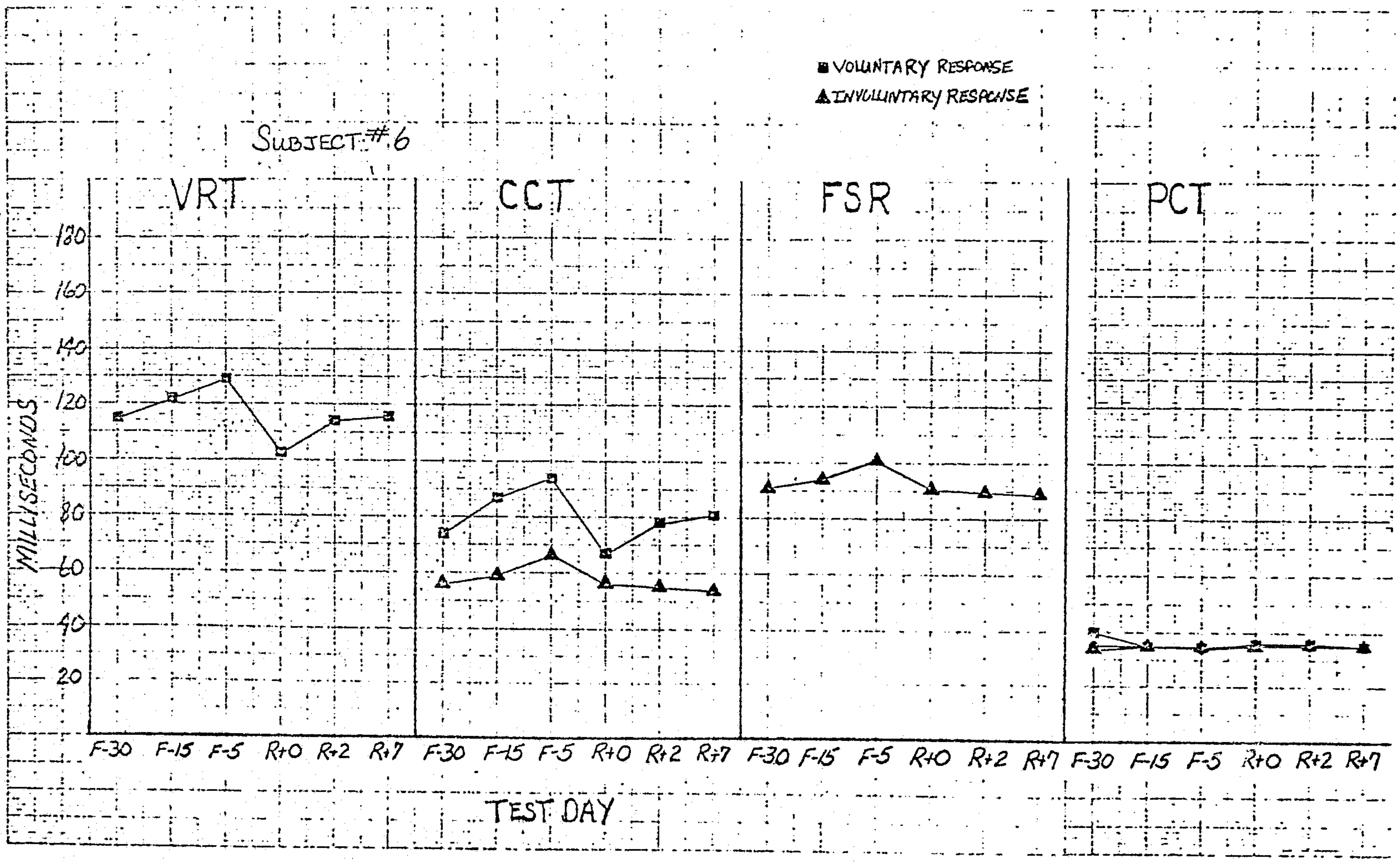

Figure 14. Response times obtained for subject 6. Conventions are those given for Figure 9.

Figure 15.

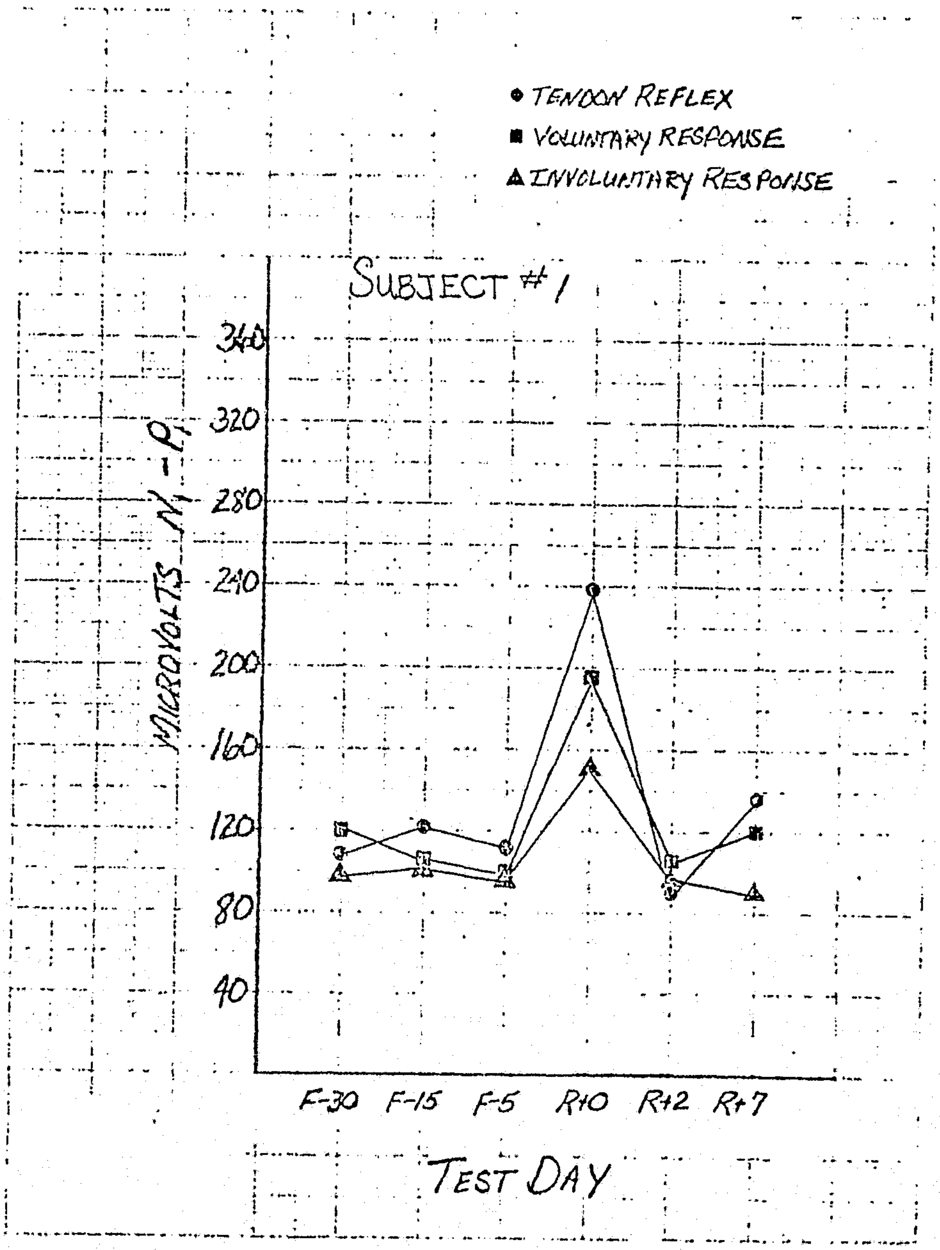

Figure 15. $N_1 - P_1$ amplitudes of the monosynaptic potentials generated in the voluntary, involuntary and Achilles reflex conditions for subject 1. Test day is represented on the abscissa and $N_1 - P_1$ amplitudes in microvolts on the ordinate.

Figure 16.

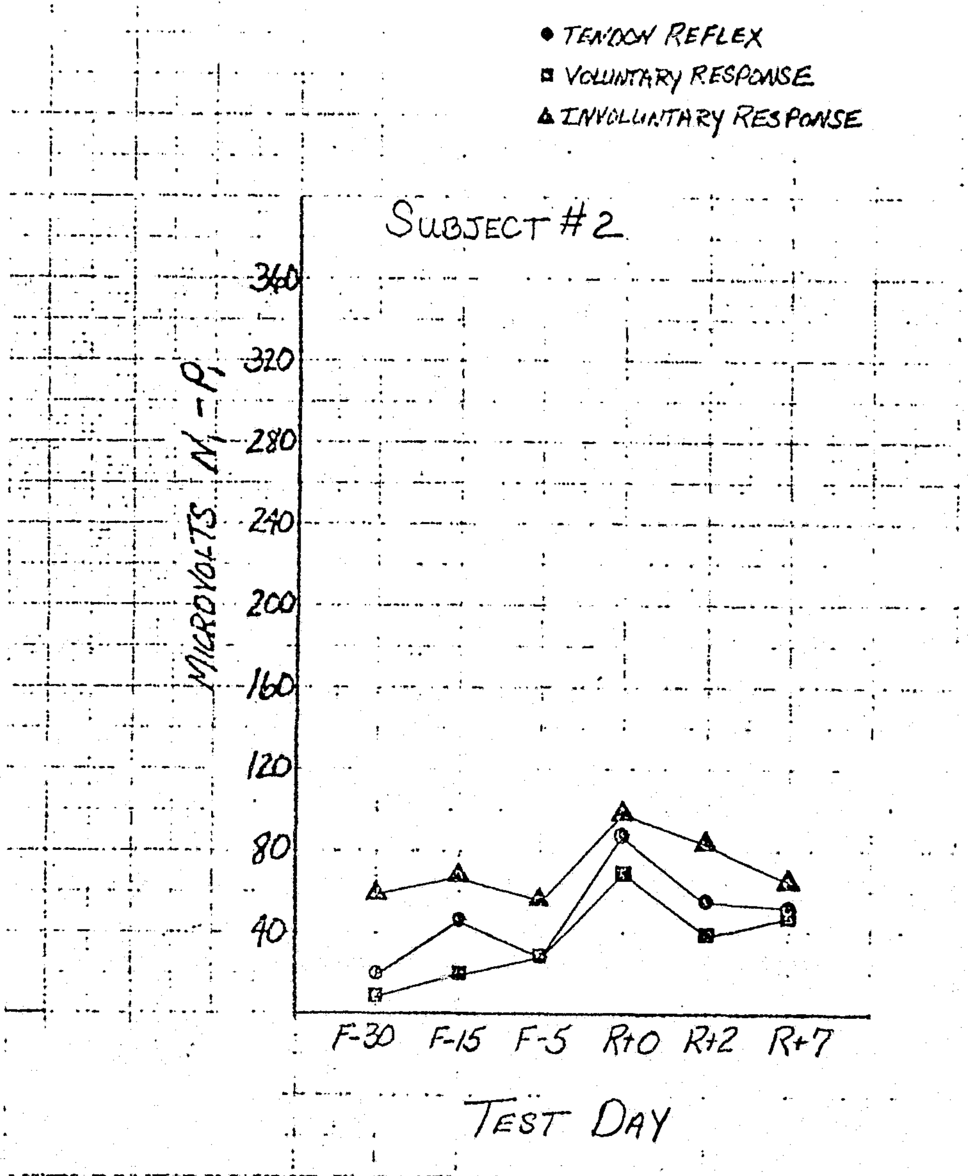

Figure 16. $N_1 - P_1$ amplitudes as measured for subject 2. Conventions are those given for Figure 15.

Figure 17.

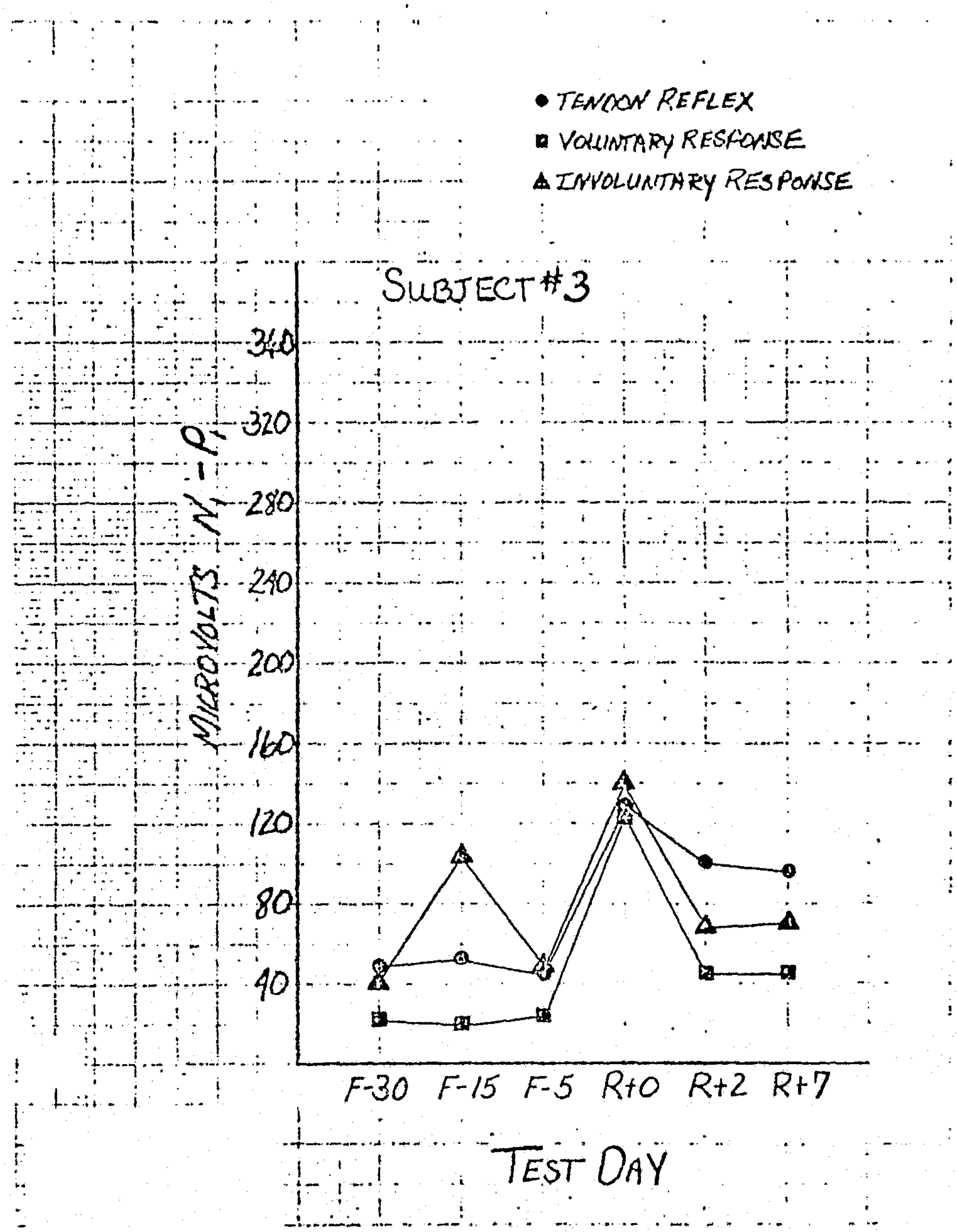

Figure 17. $N_1 - P_1$ amplitides as measured for subject 3. Conventions are those given for Figure 15.

Figure 18.

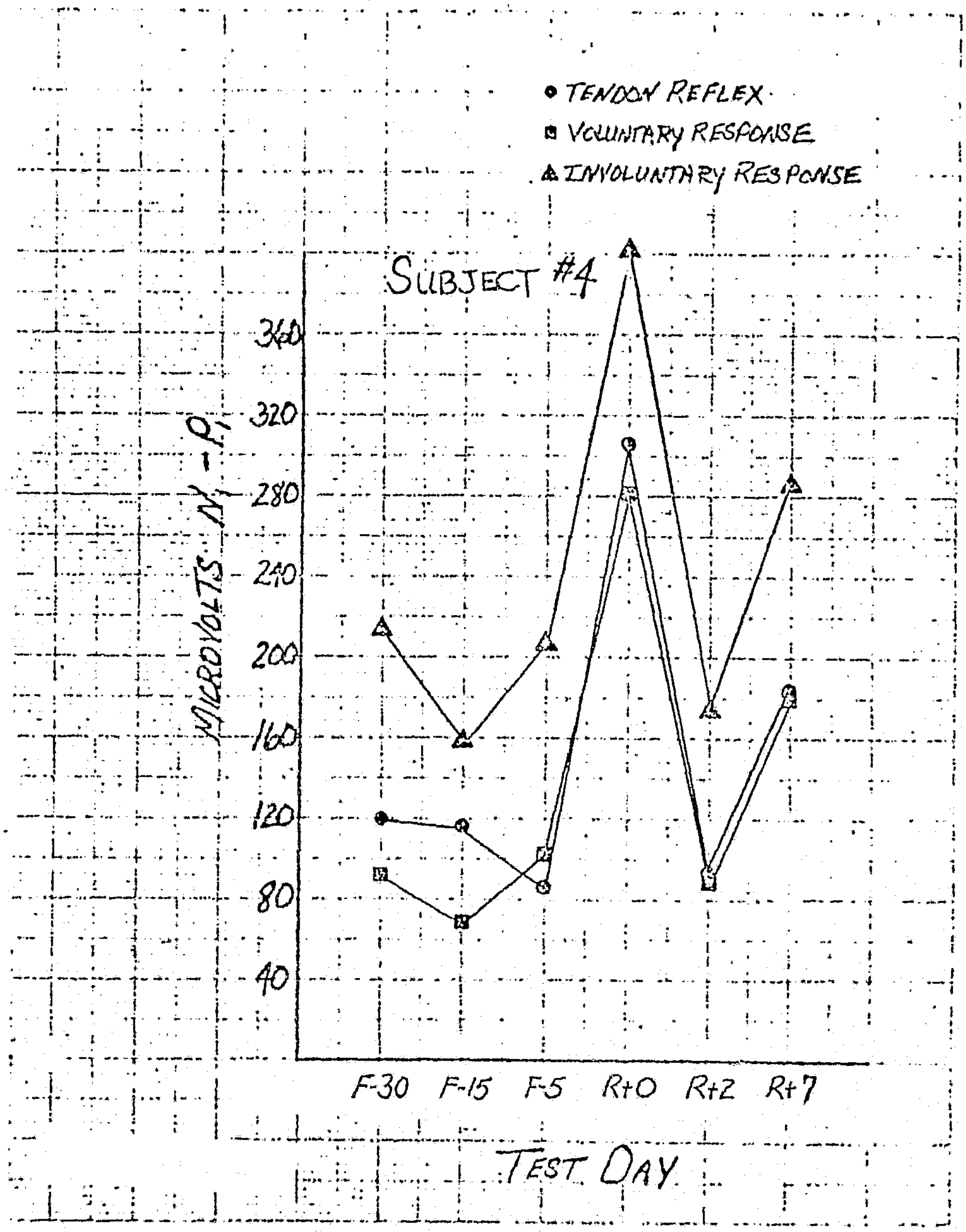

Figure 18. $N_1 - P_1$ amplitudes as measured for subject 4. Conventions are those given for Figure 15.

Figure 19.

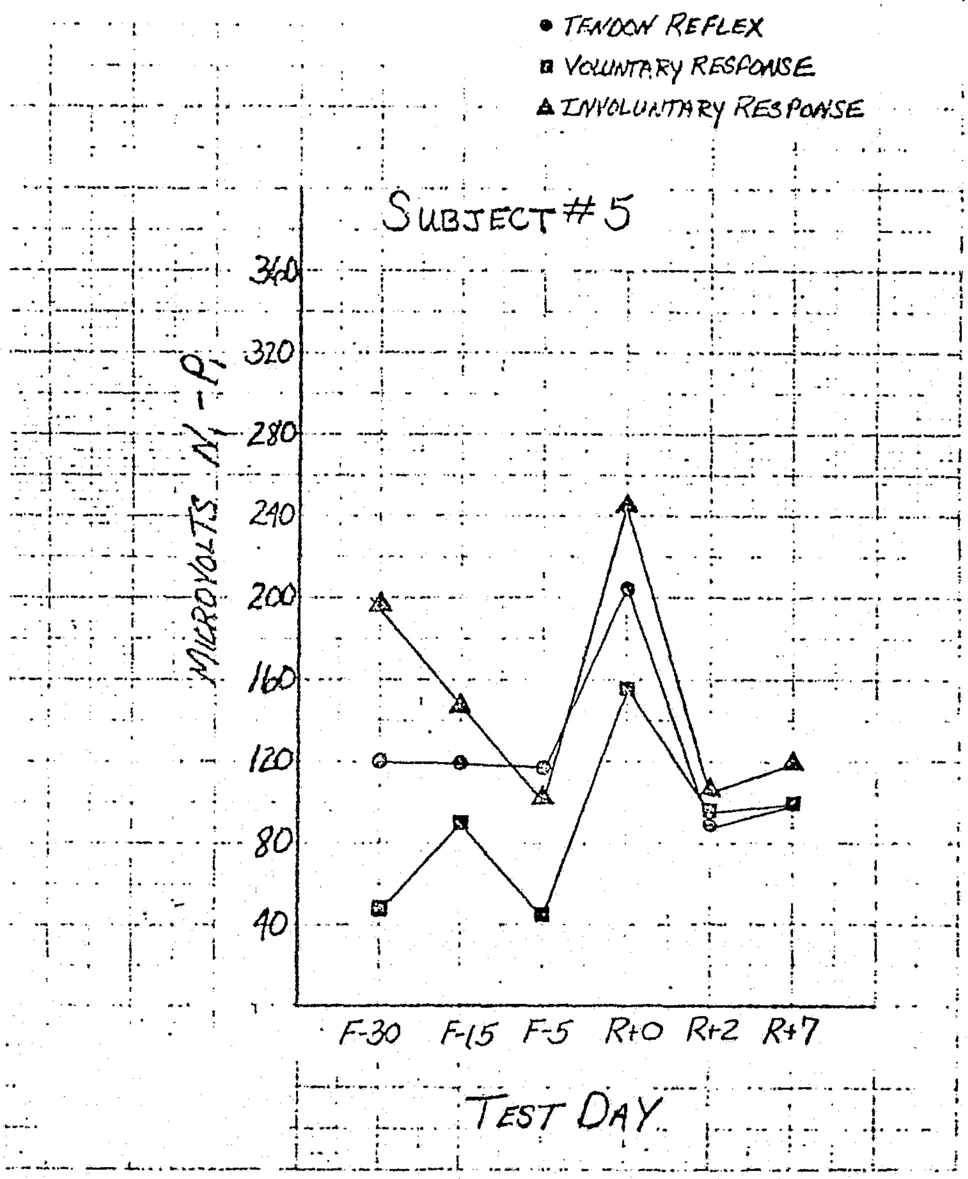

Figure 19. $N_1 - P_1$ amplitudes as measured for subject 5. Conventions are those given for Figure 15.

Figure 20

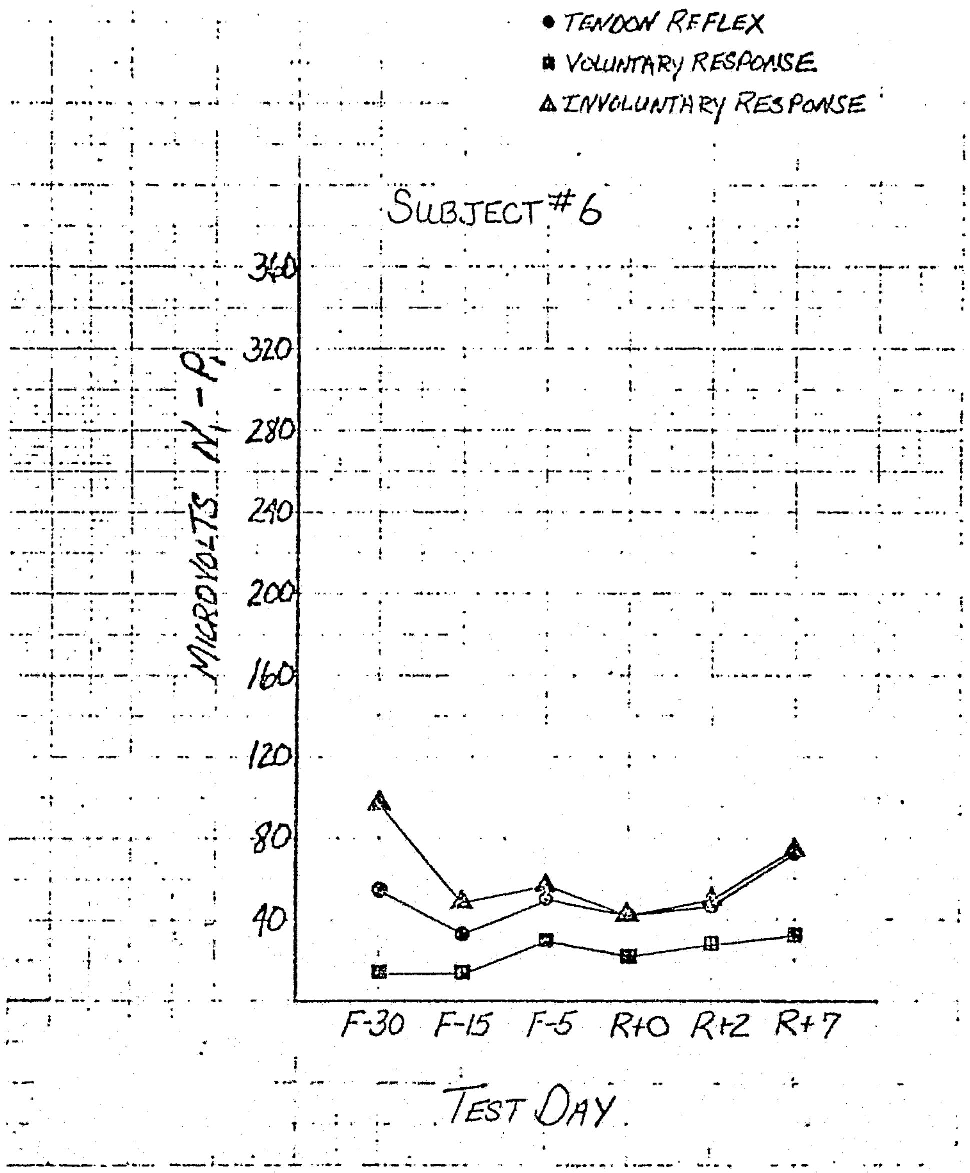

Figure 20. $N_1 - P_1$ amplitudes as measured for subject 6. Conventions are those given for Figure 15.

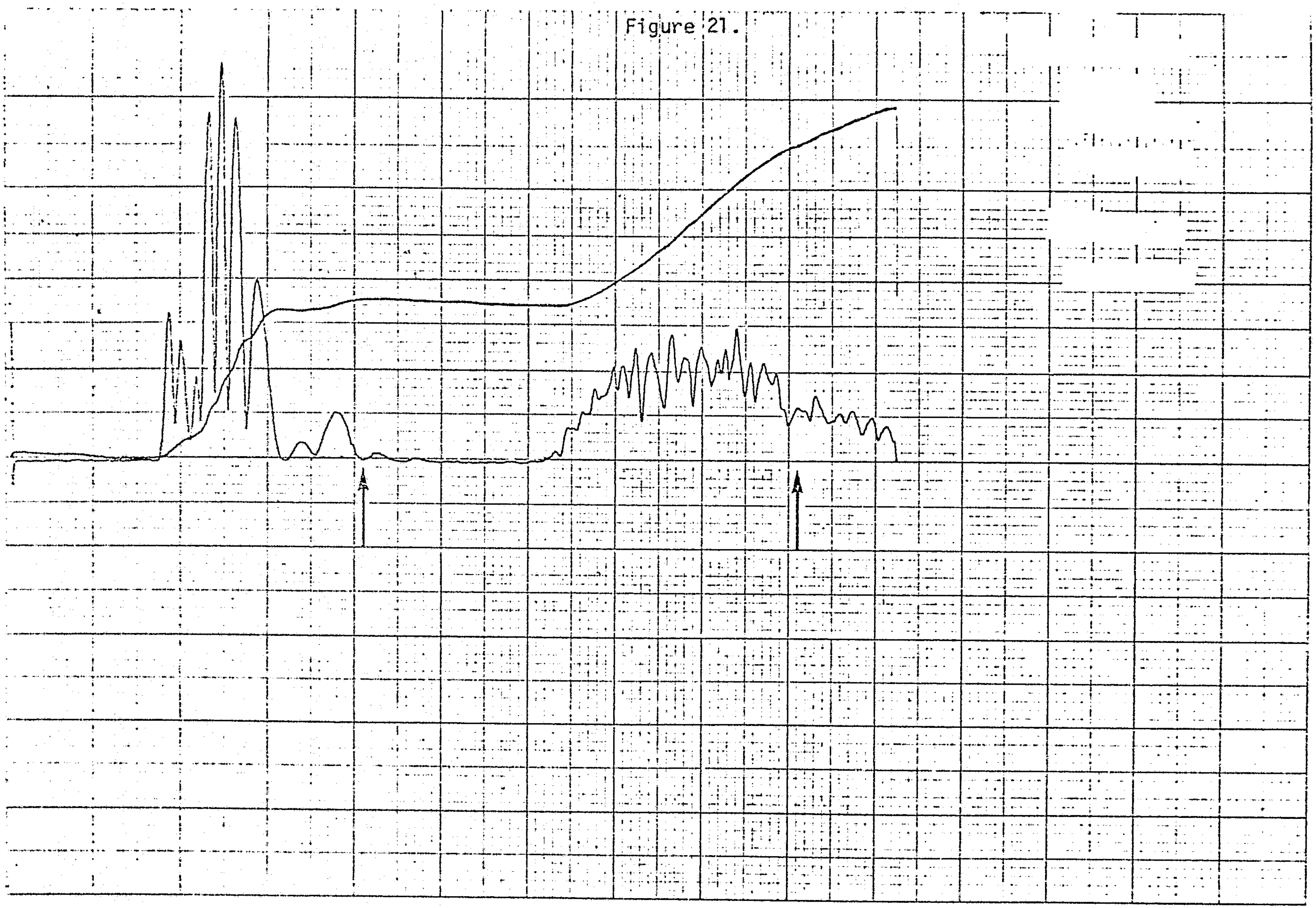

Figure 21. Sixteen rectified and averaged voluntary responses. Superimposed on the average is the integral of the entire 200 msec period. Only the integrated activity beginning 80 msec and ending 180 msec from stimulus onset was used to determine amplitude changes in the MSR. This time period is indicated by the two arrows.

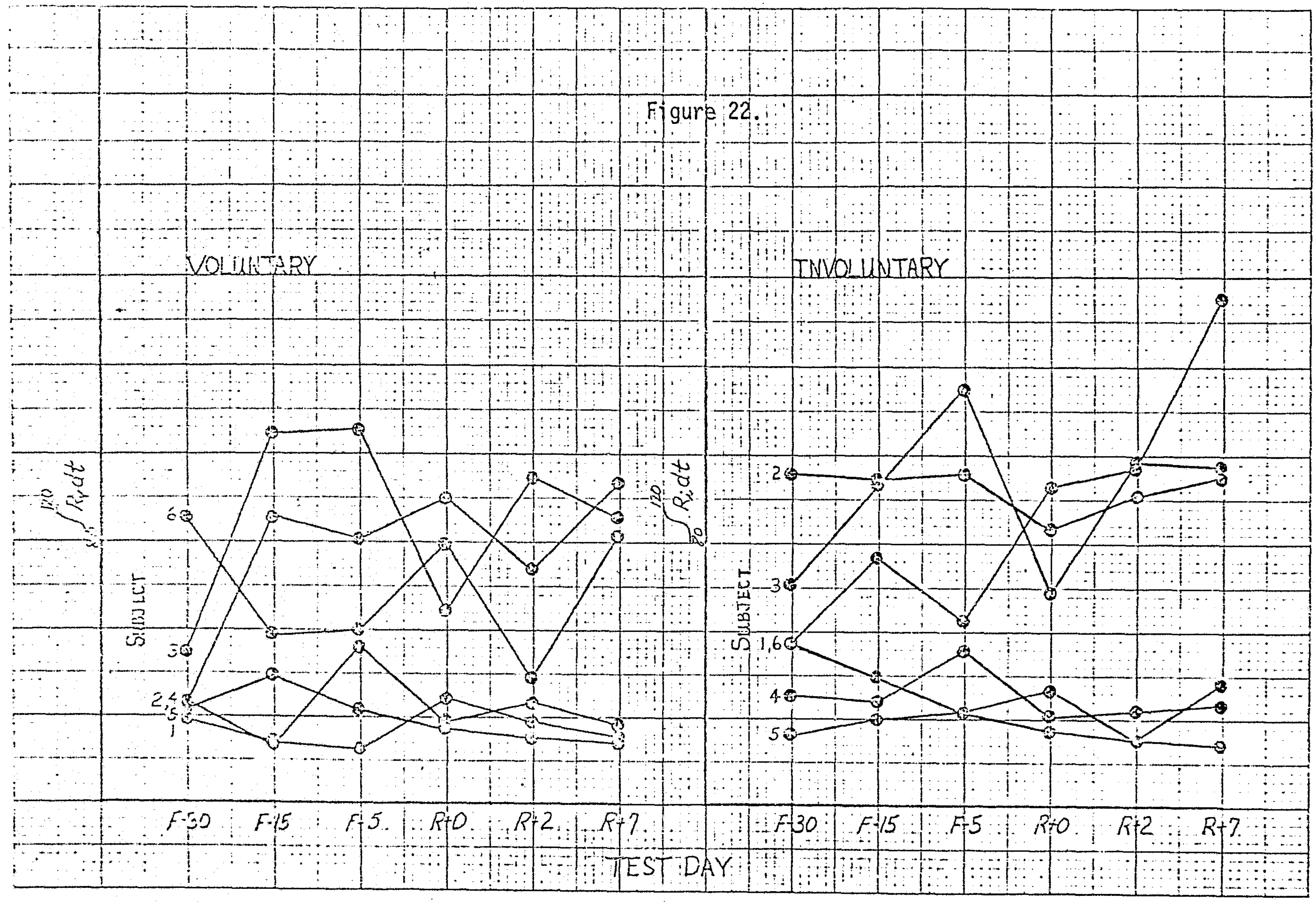

Figure 22. Integrated MSR activity for each subject's voluntary and involuntary responses.

JSC - BAYLOR BED REST STUDY I

CARDIOVASCULAR EVALUATIONS

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A. E. Nicogossian and M. M. Jackson

Recognition is given J. T. Baker, J. Donaldson, Joe Morgan, J. C. Petty and Shane Smith for their technical contributions to the conduct of this study.

E. C. Moseley, K. Tamer, D. Carr and W. Hursta performed an admirable task with DSAD personnel in data management and reduction.

Special thanks go to M. Ward and M. Taylor for typing the tables and manuscript.

The Subjects are always appreciated.

27 Aug 1975

JSC - BAYLOR BED REST STUDY I
CARDIOVASCULAR EVALUATIONS

INTRODUCTION

The effects of bed rest on the cardiovascular system are well established. Many effects parallel closely those noted in man after a period of weightlessness. In spite of the comprehensive evaluation on man during and after bed rest there are no reported bed rest studies which utilized the exact protocols, equipment, and time schedules as were employed during Skylab. It was therefore considered reasonable to conduct a bed rest study which employed the unique features of the Skylab medical evaluations and to compare the results with those obtained from the Skylab astronauts after prolonged weightlessness.

METHODS

Cardiovascular responses to a two-week bed rest period were studied in six normal males. Test protocols were adapted from the pre- and postflight measurements from Skylab (6) evaluations and included a lower body negative pressure (LBNP) stress test with increments of negative pressure from 0 to 50 mm Hg, over a 15-minute period (Figure 1). Before, during, and after each LBNP test vectorcardiogram, phonocardiogram, pneumogram, percent leg volume change, and blood pressure were obtained. Leg volume and systolic time intervals (STI) were also measured at the time of LBNP testing.

Each subject participated in three tests prior to the bed rest period in order to obtain baseline data and to familiarize the subjects with the test protocol. After completion

of two weeks absolute bed rest and before being ambulated, each subject was tested again. Subjects were also tested on each of the two days immediately following ambulation. LBNP tests were not performed during bed rest; however, leg volume and STI determinations were obtained on several days during this period.

Equipment for the study included the instrumentation from the Skylab One-g trainer where preflight exams had been performed. The environment, however, was not as controlled, and some of the pre- and post- bed rest data was compromised. The major source of environmental interference came from a radio station (RF interference) and from an unknown mechanical source (vibration interference). In addition to loss of time code, the STI data during all LBNP tests were uninterpretable. Three tests were aborted because of electrical power failure to the experiment room. All initial pre- bed rest tests were conducted with environmental temperatures above desired limits.

RESULTS

Tables I - V provide basic data about the individual tests for each subject both for reference and as a measure of experimental design and environmental control. The only notable departures from desired conditions were the somewhat elevated environmental temperatures during the first pre- bed rest tests.

Tables VI and VII give maximal calf girths and total leg volumes, the latter having revealed in space crews decrements of over a litre after flight. The very negligible

changes in leg size during bed rest definitely do not parallel those seen during and after space flight. Figures 2 and 3 present these data more dramatically by including multiple serial measurements made during bed rest. A very modest increment (~ 100 - 200 ml) in leg volume is evident in the immediate post- bed rest period.

Tables VIII, IX and X present a complete overview of heart rates, systolic and diastolic blood pressures for every test period of all tests on all subjects. Only group mean resting heart rate (Table XII) was not returned within the pre- bed rest 95% fiducial limits by the BR + 2 test. Blood pressure did not significantly change.

Maximal percentage change in calf size during LBNP, shown in Tables XI and XII, seems to imply an augmentation for the group mean immediately after bed rest, but this is not statistically significant compared to pre- bed rest ficudial limits.

SYSTOLIC TIME INTERVALS

Table XIII shows the individual STI (PEP/LVET) and heart rate responses during bed rest. The pre- bed rest and post bed rest data were unacceptable for interpretation because of environmental interference. Heart rate tended to increase during the bed rest period (75 to 80). The fact that resting heart rate was elevated prior to ambulation or exposure to the post bed rest environment would indicate that this finding was the result of bed rest, per se, rather than emotion.

The PEP/LVET measurement of STI varied considerably during the two-week bed rest period when compared with circadian rhythm of this measurement. However,

because STIs were always measured near the same time of day, the circadian rhythmicity effect should have been minimized. Initially the group mean PEP/LVET was 0.32, while at the end of bed rest it was 0.37 ($p < .05$). Therefore, the STI data from Skylab and two weeks of bed rest are directionally similar. The magnitude of change, however, is not as great for bed rest. Furthermore, there was no significant change in PEP/LVET at the end of one week, i.e., PEP/LVET = 0.34 at seven days ($p < .10$).

VECTORCARDIOGRAM

Predictable effects of LBNP on certain VCG elements were observed. Concurrent with elevated heart rate were decreased PR interval ($p < 0.05$), QRS duration (NS), and QT interval ($p < 0.01$). In addition, the P-wave maximal spatial vector magnitude increased dramatically ($p < 0.05$) while ST maximal vector magnitude decreased (NS) and little consistent alteration occurred in QRS vector dimensions. The J vector magnitude and the QRS-T spatial angle also increased (NS).

On the other hand, the effects of bed rest on the VCG differed in several respects from those observed after space flight. While resting heart rate was significantly elevated in the first post bed rest test, neither PR interval nor QRS duration was significantly further elevated in the resting state. Maximal vector magnitudes of P-wave, QRS, and ST loops under resting supine conditions were either not significantly elevated or decreased after bed rest; all were significantly elevated after space flight. And though the J vector magnitude and the QRS-T spatial angle were not significantly changed by either environmental condition, their alterations were in opposite directions after space flight and bed rest.

DISCUSSION

The cardiovascular responses to weightlessness are fairly well established and have been reported in a recent symposium (6). Basically, there is an absolute reduction in blood volume (plasma volume) in response to what is probably sensed as a volume expansion by receptors in the chest. Fluid moves along a pressure gradient from the legs into the upper body, and central circulation. Part of the fluid is stored in these spaces while the remainder is removed from the body probably as urine and/or insensibly over one to three days of weightlessness (1, 2).

As long as the null gravity environment is imposed, cardiovascular function appears to be intact – in spite of the absolute volume decrement. However, transition to one-g leads to problems related to the relative volume deficiency including orthostatic intolerance (3, 5). And symptoms associated with standing or LBNP last at least as long as it takes the body to restabilize at an adequate blood volume for the gravity field.

Bed rest has been used repeatly as an analog to weightlessness. Although the body at supine rest is within a gravitational field, this force is exerted perpendicular to the long axis. The body is deprived of the usual gravity stimulus since the gravity vector measured in the foot-to-head axis is zero with the subject in a supine position.

The bed rest model has also been used because at least some responses to it are similar to weightlessness exposure. After three weeks of absolute bed rest, blood volume is decreased and there are decrements in exercise and orthostatic tolerances. Although plasma volume is regained within three or four days after ambulation, there

is a definite delay in LBNP and exercise tolerance (5, 7).

Results of the present study, during which subjects were exposed to two weeks of absolute bed rest, are consistent with other studies of similar duration. Heart rate was elevated during supine rest and especially in response to LBNP stress compared with baseline values (Table VIII). Two of six subjects developed pre-syncope during the first LBNP test after bed rest, but before ambulation. This number is comparable to the Skylab experience in which four of nine crewmen suffered an orthostatically induced syncopal episodes after return to earth.

Of interest are the data on weights and leg volumes. There was only a small decrement in leg volume in three of the six subjects compared with 100 percent of Skylab and ASTP crewmen. Inflight leg volume determinations during the ASTP (nine day) mission showed that these crewmen had lost 5 - 10 percent of leg volume by 32 hours after launch. Weight change was negligible in the bed rested subjects, but weight loss was almost always noted in U. S. astronauts upon return from weightless flight. These data suggest that there are significant differences between true weightlessness and the bed rest analog – in spite of definite similarities in orthostatic responses.

Resting, supine PEP/LVET which is independent of heart rate change was significantly increased after bed rest (Table XIII). The mean value was $0.32 \pm .02$ prior to bed rest and $0.37 \pm .03$ afterward. The Skylab III crewmen PEP/LVET climbed from 0.32 preflight to 0.41 postflight. Therefore, according to this measurement of cardiovascular integrity, the bed rest subjects had a similar, but

not equal change compared with the Skylab crewmen. It is unfortunate that the STI data were uninterpretable during LBNP stress, especially since the stressed heart rate and blood pressure responses were similar to the astronaut data, both from Skylab and Apollo Programs.

Selected elements of the vectorcardiogram showed alterations and responses to LBNP essentially like those previously reported (4). However, under resting, supine conditions VCG responses after bed rest differed distinctly from those after space flight. If headward fluid shifts are contributing to the observed VCG changes, there must be qualitative as well as quantitative differences between the effects of supine bed rest and space flight.

It would appear that certain cardiovascular responses to supine bed rest are similar, but not equal to those noted after exposure to weightlessness. The incidence of presyncope and the overall decrement in orthostatic tolerance are almost the same. However, other responses to bed rest seem almost opposed to those after space flight. Mechanisms may be quite different when one considers the leg volume and weight data from the two groups. At this time, it is clear only that supine bed rest does not reproduce the entire picture observed in cardiovascular physiology after space flight. It is possible that some degree of head-down tilt may provide a better approximation to the cardiovascular effects of space flight.

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NASA-S-74-3245

THE LOWER BODY NEGATIVE PRESSURE PROTOCOL USED FOR SKYLAB CARDIOVASCULAR EVALUATIONS ASSESSING ORTHOSTATIC TOLERANCE

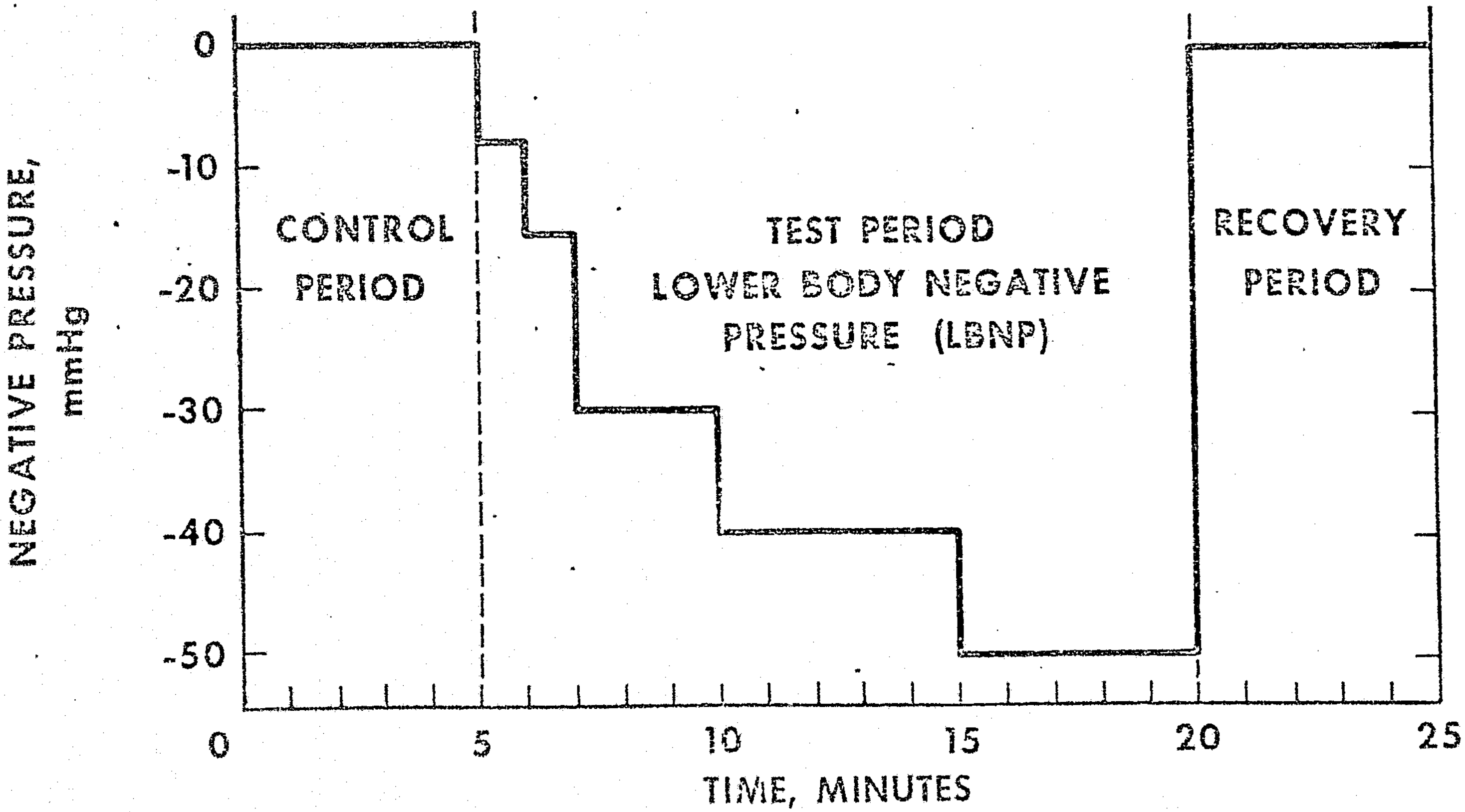
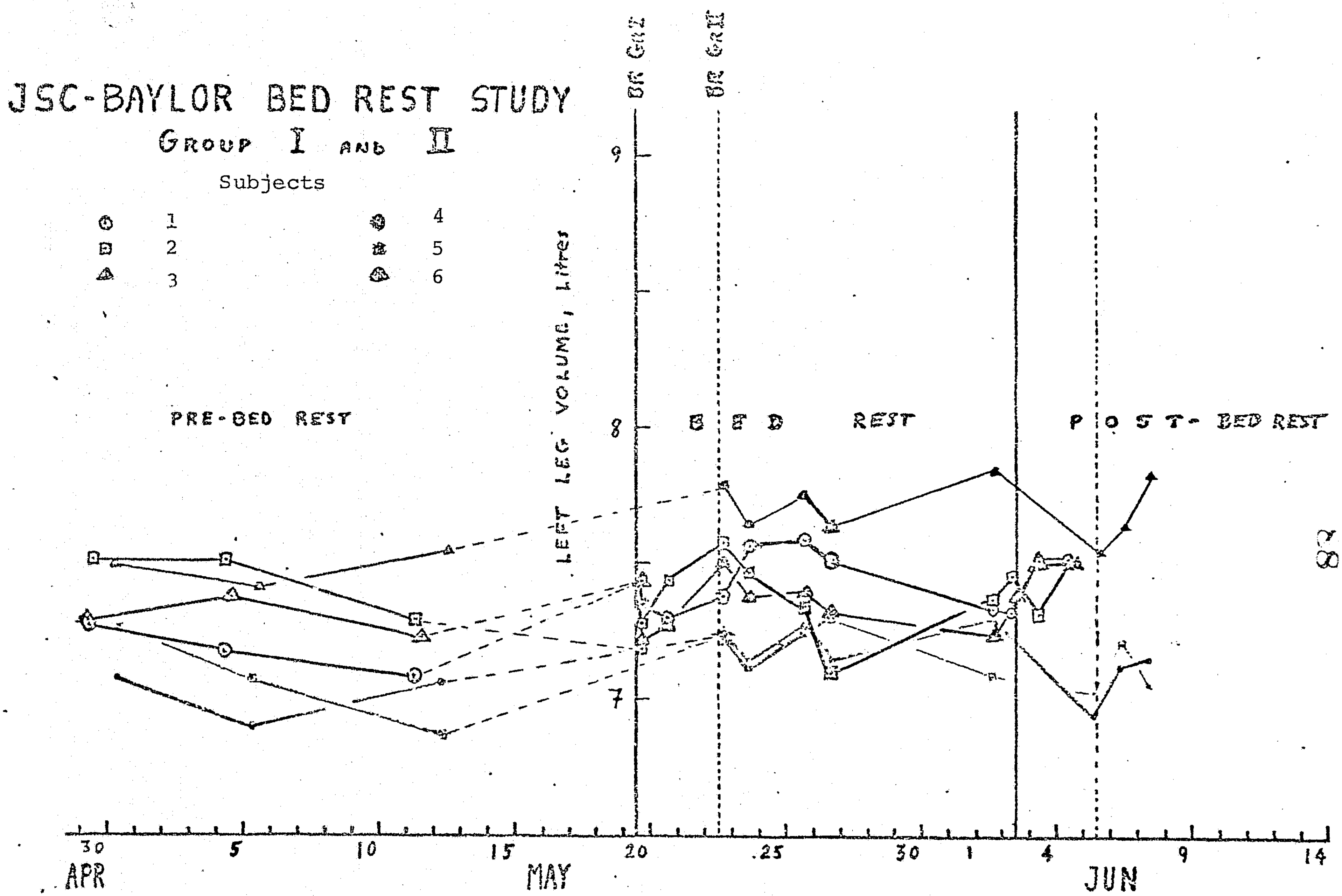


FIGURE 1

27


JSC-BAYLOR BED REST STUDY
GROUP I AND II
Subjects
1
2
3
4
5
6
BR GR I
BR GR II
PRE-BED REST
BED REST
POST-BED REST
LEFT LEG VOLUME, Litres
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8
7
30
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25
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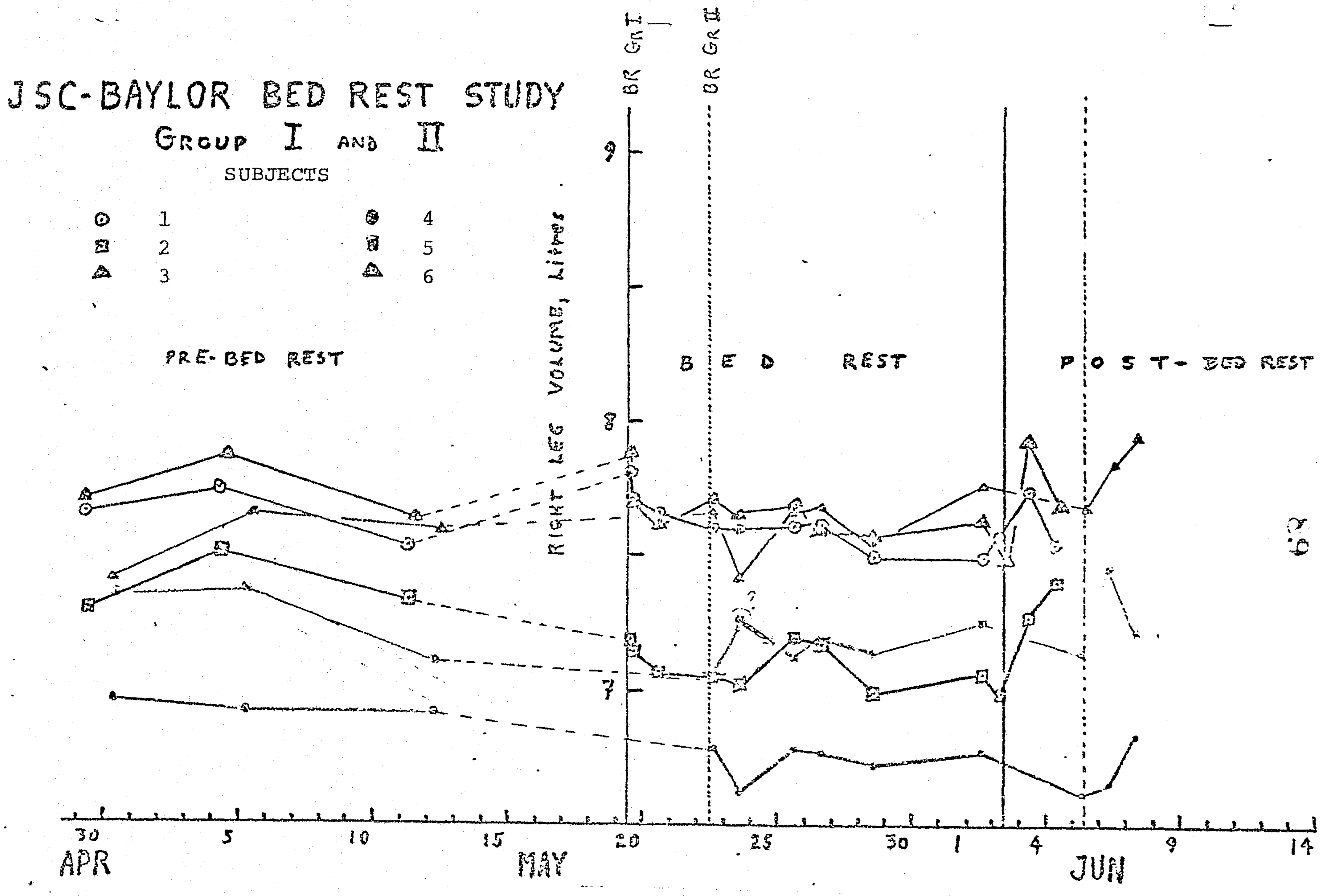
MAY
JUN

FIGURE 2


JSC-BAYLOR BED REST STUDY
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RIGHT LEG VOLUME, Liters
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JUN

FIGURE 3

TABLE I

JSC-BAYLOR BED REST STUDY I

Cardiovascular Evaluations - Date/Time (CDT)

SUBJECT	BR-20	BR-15	BR-8	BR+0	BR+1	BR+2
1	30 April 75 11:19	5 May 75 09:03	12 May 75 08:49	3 June 75 09:36	4 June 75 09:05	5 June 75 08:43
2	30 April 75 12:20	5 May 75 10:43	12 May 75 09:52	3 June 75 10:22	4 June 75 11:01	5 June 75 09:22
3	30 April 75 10:23	5 May 75 13:56	12 May 75 13:29	3 June 75 13:43	4 June 75 12:27	5 June 75 12:19
4	1 May 75 10:47	6 May 75 08:59	13 May 75 08:48	6 June 75 09:03	7 June 75 09:02	8 June 75 08:39
5	1 May 75 11:47	6 May 75 10:00	13 May 75 09:41	6 June 75 10:01	7 June 75 10:25	8 June 75 09:37
6	1 May 75 09:52	6 May 75 13:04	13 May 75 13:28	6 June 75 13:34	7 June 75 12:05	8 June 75 11:50

TABLE II

JSC-BAYLOR BED REST STUDY I

Cardiovascular Evaluations

Hours of Sleep/Hours Since Eating

SUBJECT	BR-20	BR-15	BR-8	BR+0	BR+1	BR+2
1	8 2 1/2	7 1 1/4	6 1	8 2	6 1	5 1
2	7 3 1/2	7 2	7 1/2 2	8 2 1/2	7 1/2 3	9 2
3	6 1 1/4	5 1/2 1 1/2	5 1	4 1 1/2	5 4	5 2
4	7 1 1/4	6 1/2 1	7 1	5 1/2 1	7 1/2 1 1/2	6 1
5	7 2	6 1	7 1/2 1 1/2	8 1	8 2 1/2	9 1 1/2
6	7 1 1/2	8 2	10 1 1/2	7 2	7 3	13 3

TABLE III

JSC-BAYLOR BED REST STUDY I

Cardiovascular Evaluations

Weight (kg)/Oral Temperature (°F) [°C]

SUBJECT	BR-20	BR-15	BR-8	BR+0	BR+1	BR+2
1	68.5	68.3 98.6 [37.00]	68.7 97.2 [36.22]	 97.5 [36.39]	69.3 97.6 [36.44]	69.4 97.6 [36.44]
2	70.9	71.0 98.5 [36.94]	71.0 98.3 [36.83]	71.1 98.6 [37.00]	71.1 98.1 [36.72]	71.0 98.1 [36.72]
3	69.2	68.7 98.7 [37.06]	69.7 98.0 [36.67]	70.0 98.7 [37.06]	69.3 98.2 [36.78]	69.7 98.6 [37.00]
4	64.4	64.9 98.6 [37.00]	64.2 97.9 [36.61]	64.7 98.7 [37.06]	64.4 99.0 [37.22]	64.3 97.7 [36.50]
5	82.1	82.6 98.6 [37.00]	81.6 98.0 [36.67]	82.1 97.3 [36.28]	82.1 98.2 [36.78]	82.1 98.0 [36.67]
6	63.3	63.8 98.5 [36.94]	64.0 97.7 [36.50]	65.7 98.4 [36.89]	65.5 97.7 [36.50]	65.3 97.6 [36.44]

TABLE IV

JSC-BAYLOR BED REST STUDY I

Cardiovascular Evaluations

Room Temperature °F (Beginning-End)

SUBJECT	BR-20	BR-15	BR-8	BR+0	BR+1	BR+2
1	76.0- 76.0	70.5- 71.5	67.5- 68.5	66.5- 66.5	63.5- 63.5	65.0- 65.0+
2	77.0- 76.0	72.5- 73.5	72.0- 70.0	67.5- 66.5	65.0- 64.5	66.5- 66.5
3	74.5- 75.5	70.5- 71.0	72.5-	69.0- 70.0	69.0+- 69.0	66.5- 67.0
4	75.5-	67.5 68.0	67.5- 68.0	65.0- 65.5	66.0- 66.5	73.5- 73.0
5	76.5- 77.5	68.5- 69.0	69.5- 70.0	66.0- 66.0	70.0- 70.0+	72.5- 73.0
6	74.5-	69.5 70.5	70.0- 70.0+	70.5- 71.5	70.5- 71.0	71.75 - 72.0

TABLE V

JSC-BAYLOR BED REST STUDY I

Cardiovascular Evaluations

LBNP Temperature $^{\circ}F$ (Beginning-End)

SUBJECT	BR-20	BR-15	BR-8	BR+0	BR+1	BR+2
1	77.5- 78.5	71.5- 72.5	70.5- 72.0	66.5- 69.0	67.5- 69.0	68.5- 71.0
2	78.5- 79.0	74.5- 75.4	79.5- 73.5	68.5- 69.5+	70.0- 72.5	71.0- 72.0
3	76.0- 78.0	73.0- 74.5	74.0-	71.5- 70.0	72.5- 74.5	72.0- 73.5
4	77.5-	69.5- 70.5	69.5- 71.5	68.0- 70.0	67.5- 71.5	75.5- 76.0
5	79.0- 80.0+	70.5- 72.0	72.5- 73.5	71.0- 72.0	70.5- 72.0+	75.0- 76.0
6	75.2-	71.5- 73.5	72.0- 73.0+	72.0- 71.5	71.5- 74.0	73.5- 75.0

TABLE VI

JSC-BAYLOR BED REST STUDY I

Cardiovascular Evaluations

Calf Circumference Left/Right (cm.)

SUBJECT	BR-20	BR-15	BR-8	BR+0	BR+1	BR+2
1	34.29	34.61	34.93	33.97	34.29	34.93
	34.61	35.24	35.88	33.97	34.29	34.93
2	33.02	33.66	33.66	32.70	32.70	33.34
	32.70	33.02	33.02	32.07	32.70	32.70
3	35.88	36.20	35.88	34.93	36.51	36.20
	36.83	36.83	35.56	36.51	37.15	36.83
4	33.02	33.34	33.34	32.39	32.39	32.39
	32.70	32.70	33.02	31.75	31.43	32.39
5	34.93	34.93	34.93	33.97	34.93	34.61
	34.61	34.93	34.93	33.97	34.61	33.97
6	34.29	34.61	34.61	33.34	34.29	34.29
	34.61	34.93	34.93	33.66	34.61	34.93

TABLE VII

JSC- BAYLOR BED REST STUDY I

Cardiovascular Evaluations

Leg Volume Left/Right (ml.)

SUBJECT	BR-20	BR-15	BR-8	BR+0	BR+1	BR+2
1	7274 7661	7173 7750	7088 7541	7320 7572	7511 7744	7517 7538
2	7516 7302	7507 7512	7291 7337	7452 6990	7316 7258	7501 7383
3	7287 7720	7382 7873	7233 7639	7394 7478	7511 7928	7508 7685
4	7079 6969	6898 6917	7060 6719	6945 6611	7123 6650	7148 6828
5	7263 7343	7076 7373	6866 7104	7034 7126	7205 7451	7053 7204
6	7497 7413	7402 7655	7549 7593	7538 7679	7632 7831	7819 7939

95

TABLE II

JSC - BAYLOR BED REST STUDY I
CARDIOVASCULAR EVALUATIONS - HEART RATE

Subject	Test Period	BR-20	BR-15	BR-8	Mean	± SD	BR+0	BR+1	BR+2
	C	67	66	66	66	0.6	71	73	71
1	-30	66	70	68	68	2.0	75	76	77
	-40	76	73	73	74	1.7	84	86	81
	-50	79	75	71	75	4.0	90	91	88
	R	57	58	60	58	1.5	61	69	64
	C	81	71	66	73	7.6	69	71	73
2	-30	86	70	66	74	10.6	75	72	75
	-40	92	72	72	79	11.6	86	76	82
	-50	96	78	77	84	10.7	92	80	85
	R	76	66	63	68	6.8	63	66	71
	C		69	68	69	0.7	77	81	78
3	-30		73	78	76	3.5	91	88	88
	-40		81	89	85	5.7	109	96	101
	-50		85	97	91	8.5	108	109	109
	R		62	57	60	3.5	68	76	72
	C	71	66	66	68	2.9	72	75	69
4	-30	86	82	82	83	2.3	90	82	76
	-40	98	97	99	98	1.0	113	96	88
	-50	113	113	123	116	5.8	133	113	98
	R	61	59	57	59	2.0	71	62	57
	C	68	67	64	66	2.1	69	69	73
5	-30	68	70	63	67	3.6	75	72	79
	-40	68	72	70	70	2.0	85	77	85
	-50	78	78	80	79	1.2	95	81	91
	R	61	63	56	60	3.6	68	64	69
	C	68	68	70	69	1.2	77	73	73
6	-30	68	69	71	69	1.5	83	69	72
	-40	71	68	75	71	3.5	93	73	75
	-50	75	84	80	80	4.5	102	88	82
	R	66	67	66	66	0.6	76	72	69

TABLE X

JSC - BAYLOR BED REST STUDY I
CARDIOVASCULAR EVALUATIONS - SYSTOLIC BLOOD PRESSURE

Subject	Test Period	BR-20	BR-15	BR-8	Mean	± SD	BR+0	BR+1	BR+2
	C	90	97	96	94	3.8	113	106	99
1	-30	82	91	97	90	7.6	109	107	96
	-40	81	92	93	89	6.7	110	104	93
	-50	85	92	94	90	4.7	107	106	91
	R	95	104	102	100	4.7	120	114	102
	C	97	100	96	98	2.1	107	94	99
2	-30	96	99	95	97	2.1	104	87	94
	-40	89	95	91	92	3.1	99	87	90
	-50	86	95	92	91	4.6	93	84	91
	R	107	103	100	103	3.5	113	93	101
	C		93	101	97	5.7	108	99	100
3	-30		91	95	93	2.8	108	100	96
	-40		88	97	93	6.4	101	102	95
	-50		90	87	89	2.1	107	102	92
	R		92	98	95	4.2	107	104	100
	C	113	112	113	113	0.6	115	112	106
4	-30	114	109	107	110	3.6	109	107	102
	-40	109	105	106	107	2.1	103	107	97
	-50	104	102	98	101	3.1	89	104	95
	R	119	120	122	120	1.5	106	119	109
	C	97	98	95	97	1.5	101	93	93
5	-30	93	98	91	94	3.6	98	91	88
	-40	92	95	84	90	5.7	98	90	88
	-50	90	89	79	86	6.1	99	86	89
	R	97	99	90	95	4.7	104	95	98
	C	93	105	96	98	6.2	102	94	98
6	-30	87	101	93	94	7.0	95	86	92
	-40	88	93	88	90	2.9	92	80	89
	-50	88	94	86	89	4.2	88	85	88
	R	97	106	99	101	4.7	102	92	88

TABL X

JSC - BAYLOR BED REST STUDY I

CARDIOVASCULAR EVALUATIONS - DIASTOLIC BLOOD PRESSURE

Subject	Test Period	BR-20	BR-15	BR-8	Mean	± SD	BR+0	BR+1	BR+2
	C	52	53	57	54	2.7	62	62	56
1	-30	46	47	49	47	1.5	58	58	54
	-40	53	50	52	52	1.5	65	56	57
	-50	50	52	52	51	1.2	66	61	54
	R	58	54	56	56	2.0	72	62	64
	C	56	57	55	56	1.0	60	54	56
2	-30	57	60	56	58	2.1	59	51	52
	-40	58	59	56	58	1.5	63	55	52
	-50	53	59	56	56	3.0	65	55	58
	R	55	63	54	57	4.9	67	54	56
	C		53	55	54	1.4	57	68	60
3	-30		56	55	56	0.7	61	69	63
	-40		58	58	58		64	70	64
	-50		56	53	55	2.1	60	73	63
	R		50	57	54	5.0	60	66	64
	C	51	46	45	47	3.2	45	45	42
4	-30	52	47	46	48	3.2	44	46	43
	-40	50	48	42	47	4.2	43	46	42
	-50	50	48		49	1.4	41	49	44
	R	50	55	50	52	2.9	60	47	44
	C	54	57	56	56	1.5	64	62	56
5	-30	59	60	58	59	1.0	64	63	57
	-40	53	60	54	56	3.8	66	60	59
	-50	50	61	55	55	5.5	66	65	62
	R	58	59	55	57	2.1	66	61	62
	C	42	49	50	47	4.4	52	52	47
6	-30	43	49	52	48	4.6	53	47	51
	-40	49	46	50	48	2.1	52	46	51
	-50	48	52	52	51	2.3	51	51	50
	R	47	48	51	49	2.1	57	49	50

TABLE XI

JSC - BAYLOR BED REST STUDY I

Cardiovascular Evaluations - Percentage Leg Volume Increase (during Max. LBNP)

SUBJECT	BR-20	BR-15	BR-8	MEAN ±	SD	BR+0	BR+1	BR+2
1	1.5	1.5	2.4	1.8	0.5	2.4	1.6	1.6
2	1.0	1.4	1.8	1.4	0.4	2.4	1.9	1.6
3		2.5	1.2 *P13	1.9	0.9	3.3 *P10	3.9	2.7
4	2.8	2.4	2.2	2.5	0.3	1.2 *P12	1.9	2.7
5	3.5	3.4	4.4	3.8	0.6	3.4	2.3	2.7
6	1.2	0.7	1.7	1.2	0.5	2.6	2.1	1.5

* Presyncope required stopping LBNP stress at designated minute.

TABLE XII

JSC - BAYLOR BED REST STUDY I

GROUP MEANS (n=6) AT REST (C) AND DURING MAXIMAL (-50 mm Hg) LBNP STRESS

Measurement	Test Period		BR-20	BR-15	BR - 8	MEAN	± SD	BR + 0	BR + 1	BR + 2
HEART RATE, bpm	C	$\overline{X}$	71.0	67.8	66.7	68.5	2.6	*75.2	**73.7	**72.8
		SD	5.8	1.9	2.1			5.8	4.1	3.0
	-50	$\overline{X}$	88.2	85.5	88.0	87.5	15.0	103.3	93.7	92.2
		SD	16.1	14.0	19.2			16.0	14.1	9.9
SYSTOLIC BLOOD PRESSURE, mm Hg	C	$\overline{X}$	98.0	100.8	99.5	99.5	6.8	107.2	99.7	99.2
		SD	8.8	6.7	7.0			6.4	7.8	4.2
	-50	$\overline{X}$	90.6	93.7	89.3	91.0	5.2	97.2	94.5	91.0
		SD	7.7	4.7	6.7			8.5	10.5	2.5
DIASTOLIC BLOOD PRESSURE mm Hg	C	$\overline{X}$	51.0	52.5	53.0	52.3	4.2	57.0	57.2	52.8
		SD	5.4	4.4	4.6			7.5	8.4	6.8
	-50	$\overline{X}$	50.2	54.7	53.6	52.8	2.9	58.2	59.0	55.2
		SD	1.8	4.9	1.8			10.2	9.1	7.3
MAXIMAL LEG VOLUME CHANGE, Percentage	-50	$\overline{X}$	2.0	1.9	2.3	2.1	1.0	2.6	2.3	2.1
		SD	1.1	1.0	1.1			0.8	0.8	0.6

* $p < 0.05$
** $p < 0.02$

TABLE XIII

JSC - BAYLOR BED REST STUDY I

Cardiovascular Evaluations - Heart Rate and PEP/LVET During Bed Rest

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14
HR, bpm	72	55	65	66	63		59	61	76	65	73			72
PEP/LVET	.35	.33	.31	.34	.37		.32	.37	.36	.37	.32			.36
HR, bpm	74	61	72	71	75		72	62	66	78	66			77
PEP/LVET	.30	.32	.35	.33	.36		.34	.40	.36	.37	.31			.40
HR, bpm	82	73		79	76		73	73	76	70	88			87
PEP/LVET	.31	.33		.32	.35		.30	.34	.35	.33	.32			.35
HR, bpm	77	76		71	68	77	78	76		73	75	71	71	85
PEP/LVET	.34	.37		.34	.39	.37	.35	.33		.33	.38	.39	.37	.40
HR, bpm	77	71		72	65	66	68	61		67	64	65	69	82
PEP/LVET	.31	.34		.34	.31	.33	.37	.32		.35	.39	.35	.35	.38
HR, bpm	68	65		66	57	68	68	75		60	63	60	78	77
PEP/LVET	.32	.35		.31	.30	.34	.36	.32		.32	.38	.35	.38	.34

JSC 14-DAY BEDREST STUDY
EXERCISE STRESS TESTING

Introduction

The response to exercise stress after periods of hypokinesia at 1-g has been utilized to evaluate cardiorespiratory changes evoked by decreased physical activity (1,5). Exercise response tests also have been utilized before, during, and after space flight to study adaptative responses to that unique environment (2,3,4). While it appears that 1-g bedrest produces responses that are similar to weightlessness, no previous studies were designed specifically to match experiment protocols and measurement techniques.

The present study was designed to evaluate physiological changes associated with weightlessness and those occurring in response to bedrest since bedrest has been considered an analog for weightlessness. The protocol incorporated the experimental systems designed for Skylab while using a bedrest period similar in duration to the length of Apollo missions. This papers reports results from these exercise response studies.

Methods

Six male subjects were selected for age and weight similarity to astronauts as well as for their apparent psychological suitability for bedrest studies. A brief anthropometric description of the subjects is given in Table 1. The subjects were maintained on a Skylab diet from 3 weeks prior to bedrest until 2 weeks following bedrest. Since the Apollo and the Skylab flight crews contained three men each, the subjects were divided into two groups of three men. The exercise

stress test schedules were those that we employed pre- and postflight during Skylab. Four baseline tests were obtained prior to bedrest. The subjects were then placed in standard hospital beds and bedrested for 14 days. The subjects were free to move in the horizontal plane during bedrest but vertical mobility was restricted to permit only rising up onto one elbow or lying in the horizontal plane with the head supported by no more than two standard hospital pillows.

The subjects were stress tested immediately upon completion of bedrest (BR+0) and on the two subsequent days (BR+1 and BR+2). All subjects were tested 7 days following end of bedrest (BR+7). Two subjects (#4 and #5) were tested again 14 days post-bedrest because their heart rates remained elevated at BR+7. The experiment hardware and protocol were described in detail previously (2).

All data from the initial baseline test were omitted from statistical analyses because most subjects showed signs of anxiety reactions as evidenced by elevated heart rates and systolic blood pressures. In general, all 5-minutes of rest data from each test were used to compute means and standard deviations for each parameter. Data from the final 3-minutes at each exercise level were used to compute means for each parameter and each subject on each test day. Mean data from the last three baseline tests on each subject were lumped to determine overall groups means and standard deviations for the group pre-bedrest responses for each parameter. The paired t-test was used to evaluate statistical significance in the comparison of pre-bedrest responses with those obtained post-bedrest. This data anlysis scheme is comparable to that

used for Skylab.

Systolic time intervals (STI) were derived from simultaneous strip-chart recordings (chart speed = 100 mm per second) of the electrocardiogram, vibrocardiogram, and carotid pulse trace. Each subject was monitored continuously. Systolic time interval data were obtained between the third and fifth minute at each protocol level. Satisfactory STI's were obtained from only four subjects.

The following STI measurements were computed:

1. The QS_2 interval (onset of Q-wave of ECG to the second sound of the vibrocardiogram)
2. LVET (left ventricular ejection time) obtained from the carotid pulse wave
3. PEP (pre-ejection period) = [QS_2 - LVET]
4. IVCT (isovolumetric contraction time) = [time from the first to the second sound - LVET]

QS_2, LVET, and PEP are functions of heart rate. The following regression equations obtained by Weissler et al. (6) were used to correct the STI measurements for heart rate (hr).

$$QS_{2c} = QS_2 + 2.1 \text{ hr}$$

$$LVET_c = LVET + 1.7 \text{ hr}$$

$$PEP_c = PEP + 0.4 \text{ hr}$$

The ratio PEP/LVET which has been demonstrated to be an indicator of ventricular function was also computed.

Results

Table 2 summarizes the statistically significant changes in heart rate, blood pressure, and stroke volume observed post-bedrest. Heart rates were elevated at rest and at all exercise levels immediately

following 14-days of bedrest. Diastolic blood pressure (DBP) and mean arterial pressure (MAP) were elevated at rest and at both 25% $V_{O_2\ max}$ and 50% $V_{O_2\ max}$ but not at 75% $V_{O_2\ max}$. Mean cardiac exercise stroke volume was significantly reduced immediately post-bedrest. The group mean values for all the above parameters had reverted to normal by the day following the end of bedrest.

Table 3 summarizes the group mean STI measurements made pre-bedrest and the percent changes noted immediately post-bedrest (BR+0). The immediate post-bedrest STI's indicated a slightly reduced ejection time (not statistically significant) and an increased pre-ejection period.

Discussion

Many similarities between the physiological responses to space flight and bedrest became apparent when comparing results from the present 14-day bedrest study to the Apollo postflight data reported by Rummel et al. (2,3). First and most striking is the fact that statistically significant changes observed on BR+0 and those observed immediately postflight (R+0) generally returned to normal within 24 hours. Resting heart rates were found to be statistically significantly elevated during both BR+0 and R+0 tests. Mechanical efficiency (V_{O_2}/watt work) was unchanged for both the Apollo crewmen and the bedrest subjects. Because there were no changes in mechanical efficiency following either bedrest or space flight, it was possible to compare several other physiological parameters in terms of their relationship to heart rate. For example, oxygen pulse (V_{O_2}/heart beat) was significantly reduced ($p < 0.05$) at a heart rate

of 160 beats/min on recovery day (R+0) following Apollo space flights. Similarly, bedrest subjects had significantly elevated heart rates on BR+0 at each protocol level implying reduced oxygen pulse values.

Heart rate was a dependent variable in Skylab where we used set work levels approximating 25%, 50%, and 75% $V_{O_2\ max}$ levels for each crewman. Heart rate was the controlled variable during Apollo testing. A comparison of blood pressure and cardiac output changes noted in both studies relies upon the previously mentioned fact that no mechanical efficiency changes were seen during either study. The group mean heart rate for level three exercise on BR+0 was 158.9 ± 7.4 beats/min which is similar to the 160 beats/min value attained during Apollo R+0 tests. Group mean heart rate was elevated 15 beats/min, relative to pre-bedrest, at 75% $V_{O_2\ max}$ on BR+0. The group mean heart rate at 50% $V_{O_2 max}$ on BR+0 was the same as that observed at 75% $V_{O_2\ max}$ prior to bedrest (146 beats/min). The corresponding group mean systolic blood pressures (SBP) were 167 mmHG at 50% $V_{O_2\ max}$ on BR+0 and 173 mmHg at 75% $V_{O_2\ max}$ prior to bedrest. Based upon these data it appears that SBP was slightly reduced for a given heart rate level on BR+0 relative to pre-bedrest. Apollo crewmen had substantially reduced SBP (-10%) on R+0 at a heart rate of 160 beats/min. Diastolic blood pressure (DBP) was found to be reduced following the early Apollo flights (2), but apparently was unchanged following the late Apollo flights (3). Diastolic blood pressure was significantly elevated post-bedrest (BR+0) at 25% $V_{O_2\ max}$ and at 50% $V_{O_2 max}$. The parallel increases in SBP and DBP observed on BR+0 resulted in significant increases in mean arterial pressure (MAP).

Reduced exercise stroke volume was compensated by tachycardia in both Apollo and bedrest subjects.

A reduced end-diastolic volume or decreased cardiac muscle contractility could have produced the STI changes noted on BR+0. All STI's returned to pre-bedrest values by BR+1. There is no evidence to support the premise of long term change in cardiac contractility. A change in total blood volume is the most plausible explanation for reduced left ventricular end-diastolic volume which in turn could lead to the STI changes that were observed.

In summary, there was a general correspondence between the exercise stress responses of six subjects following 14-days of bedrest and those of 27 Apollo crewmen following their 10-12 day missions. The basic protocol difference (set work levels *vs.* set heart rate levels) precluded a more rigorous comparison of most physiological parameters. In general our observations are similar to those of Hyatt *et al.* (1) and Saltin *et al.* (5) following their bedrest studies.

TABLE 1

Subject Number	Ht (cm)	Wt (kg)	Age (yrs)
1	180	68.6	32
2	183	71.4	27
3	178	68.9	37
4	173	65.5	24
5	170	80.6	31
6	168	63.6	30
Group $\bar{X} \pm$ SD	175.3 $\pm$6	69.8 $\pm$6.0	30.2 $\pm$4.5

TABLE 2

VARIABLE	PRE-BEDREST MEAN	PRE-BEDREST ±SD	PRE-BEDREST N	END OF BEDREST MEAN	END OF BEDREST PROBABILITY LEVEL	END OF BEDREST N	DAY AFTER END OF BEDREST MEAN	DAY AFTER END OF BEDREST PROBABILITY LEVEL	DAY AFTER END OF BEDREST N
RESTING									
Sitting Heart Rate (Beats/Min)	82.0	±5.4	18	98.3	$P \leq .005$	6	83.3	NS	6
Diastolic Blood Pressure (mmHg)	63.9	±8.3	17	75.0	$P \leq .01$	6	66.0	NS	6
Mean Arterial Pressure (mmHg)	78.7	±8.2	17	89.2	$P \leq .001$	6	80.8	NS	6
EXERCISE STRESS									
Heart Rate (Beats/Min)									
@25% $\dot{V}_{O_2}max$	101.2	±4.9	18	119.3	$P \leq .001$	6	103.1	NS	6
@50% $\dot{V}_{O_2}max$	124.2	±7.2	18	145.9	$P \leq .001$	6	128.4	NS	6
@75% $\dot{V}_{O_2}max$	144.4	±7.8	17	158.9	$P \leq .001$	4	152.2	NS	6
Diastolic Blood Pressure (mmHg)									
@25% $\dot{V}_{O_2}max$	58.2	±7.6	17	70.0	$P \leq .02$	6	61.3	NS	6
@50% $\dot{V}_{O_2}max$	60.9	±7.5	16	72.2	$P \leq .001$	6	66.2	NS	6
Mean Arterial Pressure (mmHg)									
@25% $\dot{V}_{O_2}max$	84.6	±9.2	6	97.5	$P \leq .01$	6	89	NS	6
@50% $\dot{V}_{O_2}max$	93.1	±5.7	6	103.7	$P \leq .02$	6	95.9	NS	6
Exercise Stroke Volume (ml)	77.5	±6.4	6	64.2	$P \leq .01$	6	71.8	NS	6

TABLE 3

VARIABLE	REST		25% $\dot{V}_{O_2\ max}$		50% $\dot{V}_{O_2\ max}$		75% $\dot{V}_{O_2\ max}$	
	PRE-BEDREST	POST-BEDREST %Δ	PRE-BEDREST	POST-BEDREST %Δ	PRE-BEDREST	POST-BEDREST %Δ	PRE-BEDREST	POST-BEDREST %Δ
QS_{2c}	514msec	+1%	526msec	-3%	534msec	-2%	547msec	NC
$LVET_c$	381msec	-2%	404msec	-15%	413msec	-3%	413msec	-3%
PEP_c	135msec	*+10%	125msec	*+8%	125msec	NC	125msec	+6%
IVCT	42msec	NC	30msec	+20%	25msec	-10%	21msec	NC
PEP/LVET	0.424	*+29%	0.377	+30%	0.382	+13%	0.375	+27%

*Statistically significant ($p < 0.05$)

LEGENDS

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SKYLAB SIMULATION FOURTEEN-DAY BEDREST HEMATOLOGY AND IMMUNOLOGY STUDIES

Stephen L. Kimzey

The purpose of these studies was to compare the effect of a 14-day bedrest exposure on selected hematologic and immunologic parameters in healthy adult male subjects with changes observed during the Skylab flights. The tests and procedures employed were identical to those conducted as part of the Skylab M112 and M115 Experiments protocols.

Blood Sampling Schedule. Blood samples were collected from the subjects during the pre-bedrest phase, bedrest period, and post-bedrest according to the general schedule outline in Table I. This table also indicates the distribution of blood samples among the various experiments. The actual volumes of blood withdrawn and dates for sampling each group of subjects are listed in Table II.

All samples were withdrawn from the vein with the subject in a fasting state and after he had been supine for at least 15 minutes (30 minutes on days fluid compartments were to be measured). Different anticoagulants were used, depending upon the assay to be conducted; however, all samples were processed or stabilized within minutes of collection.

Methods. Standard hematologic techniques were applied for measurement of routine parameters. Red cell counts were determined using an electronic counter (Coulter) and hemoglobin spectrophotometrically using an IL Coximeter (Model 182). Total serum proteins were measured by

refractometry and protein electrophoresis by cellulose acetate strip electrophoresis. Quantitation of other plasma proteins (immunoglobulins, haptoglobin, transferrin, ceruloplasmin, alpha-2-macroglobulin, beta-1-alpha-globulin, alpha-1-acid glycoprotein, alpha-1-antitrypsin) was by the technique of electro-immuno-diffusion (Gill, et al., 1971).

Shape classification of erythrocytes by scanning electron microscopy was by the technique of Kimzey, et al. (1974). The red cell potassium content and flux into erythrocytes were determined by flame photometry and isotope (^{86}Rb) exchange (Larkin and Kimzey, 1972).

Routine Hematology. The routine hematology data are summarized in Tables III - VIII. All of the changes noted during the bedrest and post-bedrest periods are associated with the changing states of plasma volume and red cell mass. The hemoglobin concentration was elevated in four of the six subjects during the bedrest, and decreased rapidly in all six immediately post-bedrest (Figure 1). These results are similar to those observed in Skylab 3 and 4 (Kimzey, 1975) except that the increase in hemoglobin concentration following exposure to weightlessness was more pronounced than observed in this bedrest study. In spite of the decline in red cell mass reported during the bedrest (Johnson, 1975), the reticulocyte count showed no consistent pattern throughout the study (Figure 2). The absolute reticulocyte count and reticulocyte index also remained within the pre-bedrest limits for each subject.

No changes were noted in the white blood cell count or differential, or in the platelet count during the study.

Special Hematology. Classification of red cell shapes by scanning electron microscopy demonstrated no significant alterations in the distribution of erythrocyte shapes during this study (Table IX). Changes in red cell shape distributions have been observed previously during the Skylab flights. However, most of the changes appeared to be related to mission duration, and were significant only after 28 days in space. Therefore, a 2-week bedrest exposure might not be sufficient time for any changes to become significant.

These studies would seem to indicate that during 14 days of bedrest, there were no significant alterations in the hematological parameters discussed above, except those associated with variations in red cell mass and/or plasma volume.

Immunology Studies. The humoral immunology data are summarized in Tables XI-XVI. There were individual variations in the concentration of serum proteins and particularly albumin, but no consistent trend was evident. The changes noted were most likely the result of variations in plasma volume during the bedrest and post-bedrest period.

Haptoglobin, ceruloplasmin, and A2-macroglobulin did not change. However, there was a slight decrease in transferrin in 4 of 6 subjects during the bedrest period. The cause and significance of this observation are unknown at this time.

Thus it would appear that there were no consistent abnormalities relative to the humoral immune system as a result of exposure to bedrest for 14 days. There was a slight depression in the transferrin levels which cannot be explained at the present time. These patterns are consistent with the results of Apollo and Skylab, where individual variations

in plasma proteins were observed (particularly in Apollo where haptoglobin and alpha-2-macroglobin were frequently elevated postflight), but there were no indications to suggest that the humoral immune system's functional capacity reacted to or was compromised by the weightless environment.

Summary

The results of the studies of selected hematologic and immunologic parameters during a relatively short (14-day) bedrest exposure suggest no significant changes, except those related to vascular fluid shifts. These data are comparable to those from other bedrest studies of the same duration. All of the changes reported in the Skylab experiment resulted from exposure of 2 to 6 times the duration of this test. It is possible that a bedrest exposure of longer duration would also cause red cell morphological and functional alterations similar to those characteristic of space flight. It is also conceivable that the "simulated" weightlessness of bedrest does not result in the same stresses as the weightlessness of space flight.

Table I

BLOOD SAMPLING SCHEDULE
SKYLAB SIMULATION BEDREST STUDY

Sample Day / Experiment	Pre-Bedrest					Bedrest			Post-Bedrest				
	30	21	20	7	1	2	7	13	0	1	3	7	14
M071 Biochemistry Studies	15	15		15	15				15	15	15		15
M073 Endocrinology Study	25	25		25	25				25	25	25		25
M112 Immunology Studies	10	10			10				10		10	10	
M113 Blood Volume Studies		20*	10	10	10				20*	10	10	10	10
M115 Hematology Studies	15	15	5	15	15				15	15	5	15	15
Total Volume ml/man/day	65	85	15	65	75	15	15	30*	85	65	65	35	65
Total Volume ml/man/period	305					60			315				

*Radioisotope Studies

BLOOD SAMPLE FLOW SHEET

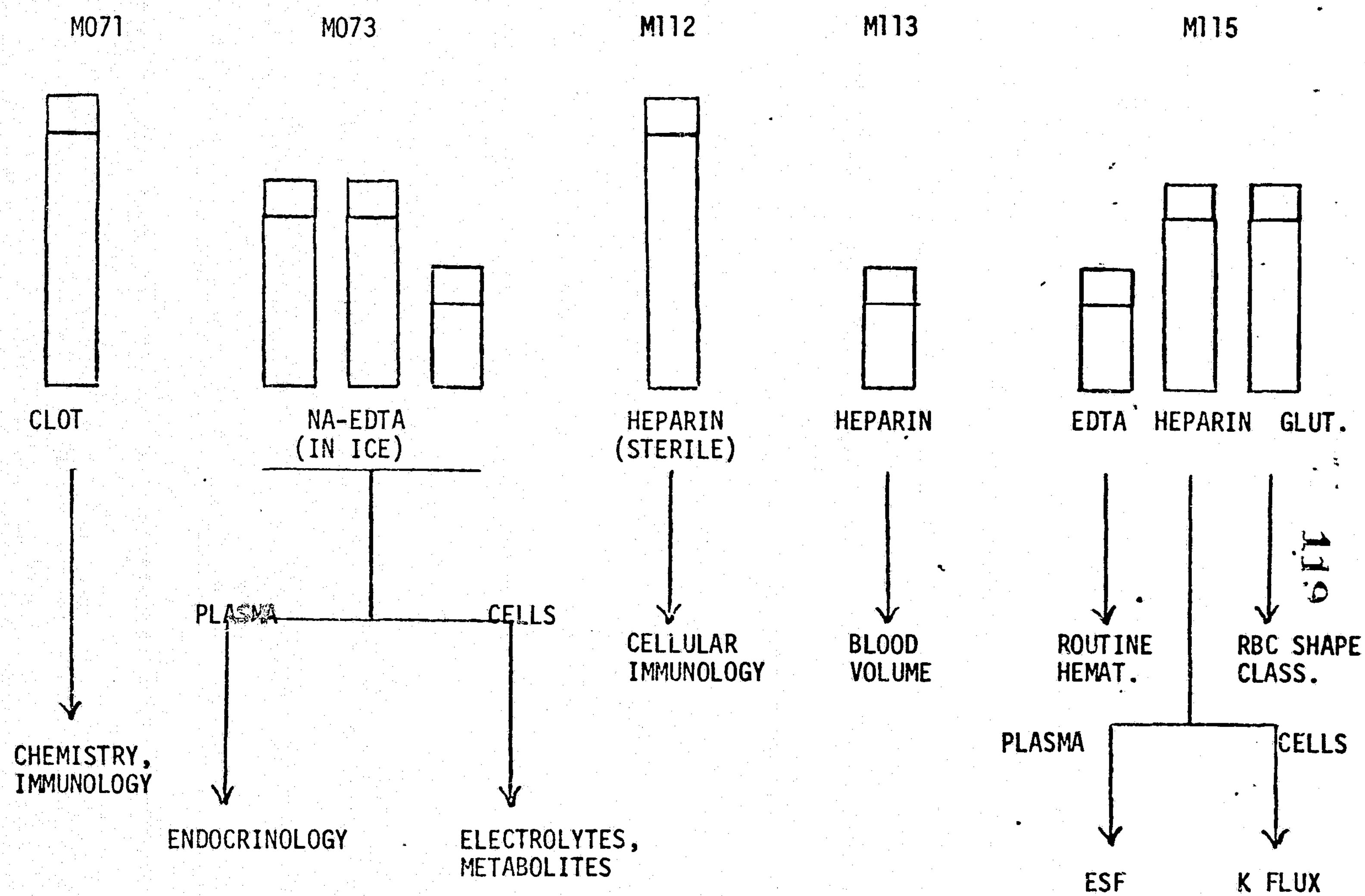


Table IA

Table II

SKYLAB SIMULATION BEDREST STUDY I

BLOOD SAMPLE SCHEDULE

MISSION DAY		BLOOD SAMPLE VOLUME	SUBJECTS 1-3 DRAW DATE	SUBJECTS 4-6 DRAW DATE
F-30		62	23 April	23 April
F-21		93	2 May	2 May
F-20		5	3 May	3 May
F-7		70	9 May	9 May
F-1		75	19 May	22 May
	TOTAL	305		
BR2		30	21 May	24 May
BR8		20	27 May	30 May
BR14		35	2 June	5 June
	TOTAL	85		
R+0		90	3 June	6 June
R+1		50	4 June	7 June
R+3		80	6 June	9 June
R+6		40	9 June	12 June
R+13		60	16 June	19 June
	TOTAL	320		
	OVERALL TOTAL	710		

Table III

HEMATOLOGY SUMMARY DATA.

SUBJECT NO. 1	PREBEDREST MEAN	PREBEDREST S.D.	BEDREST MEAN	BEDREST S.D.	POST BEDREST R+0	POST BEDREST R+1	POST BEDREST R+3	POST BEDREST R+6	POST BEDREST R+13
RBC	4.43	0.13	4.80	0.27	4.72	4.56	4.25	4.33	4.41
Retic	1.1	0.3	1.0	0.2	1.0	0.6	0.8	1.2	2.0
Hb	13.0	0.4	14.2	14.0	14.2	14.0	12.9	12.2	12.7
Hct	39.7	1.3	43.3	2.1	43	41	38	38	39
WBC	4815	221	5333	153	5500	6100	5300	4700	5600
Neut	2035	177	2669	335	3080	2867	2226	2256	3248
Lymph	2483	245	2272	372	2090	2806	2809	2209	2016

Table IV

HEMATOLOGY SUMMARY DATA

SUBJECT NO. 2	PREBEDREST		BEDREST		POST BEDREST				
	MEAN	S.D.	MEAN	S.D.	R+0	R+1	R+3	R+6	R+13
RBC	4.53	0.15	4.75	0.13	4.66	4.59	4.25	4.67	4.60
Retic	1.5	0.3	2.1	0.2	1.2	1.2	0.9	1.9	1.2
Hb	14.4	0.4	15.1	0.4	14.8	14.4	13.8	14.6	14.4
Hct	41.9	1.0	44.3	1.1	44	41	41	43.5	42
WBC	5100	294	5200	200	4300	3700	4200	5300	5000
Neut	3087	455	2947	433	1978	1813	2394	2756	2400
Lymph	1812	384	2027	320	2193	1776	1638	2385	2450

Table V

HEMATOLOGY SUMMARY DATA

SUBJECT	PREBEDREST		BEDREST		POST BEDREST				
NO. 3	MEAN	S.D.	MEAN	S.D.	R+0	R+1	R+3	R+6	R+13
RBC	4.83	0.20	5.03	0.02	4.94	4.70	4.53	4.53	4.48
Retic	0.7	0.2	0.7	0.1	0.8	1.0	1.6	0.8	0.9
Hb	15.4	0.4	15.7	0.2	15.6	15.0	14.3	14.4	13.8
Hct	46.0	0.7	47.3	0.6	46	44	42	42.5	41
WBC	8150	311	8166	569	7700	10000	9700	8300	7400
Neut	4313	440	3952	312	3619	4200	4656	5229	3922
Lymph	3590	454	3719	714	3388	5300	4850	2739	3330

Table VI
HEMATOLOGY SUMMARY DATA

SUBJECT NO. 4	PREBEDREST MEAN	PREBEDREST S.D.	BEDREST MEAN	BEDREST S.D.	POST BEDREST R+0	POST BEDREST R+1	POST BEDREST R+3	POST BEDREST R+6	POST BEDREST R+13
RBC	4.99	0.18	4.87	0.30	4.88	4.69	4.57	4.60	4.59
Retic	1.1	0.4	1.0	0.1	0.8	1.0	1.5	1.2	1.2
Hb	15.1	0.4	15.0	0.4	14.9	13.9	14.0	13.3	13.5
Hct	44.5	1.3	45.2	0.8	45	42	42	41	41
WBC	6050	656	6167	404	6400	6600	4700	5800	5400
Neut	4064	606	3823	316	3456	4290	2820	3538	2916
Lymph	1819	194	2075	254	2688	2046	1692	1914	2322

Table VII

HEMATOLOGY SUMMARY DATA

SUBJECT NO. 5	PREBEDREST MEAN	PREBEDREST S.D.	BEDREST MEAN	BEDREST S.D.	POST BEDREST R+0	POST BEDREST R+1	POST BEDREST R+3	POST BEDREST R+6	POST BEDREST R+13
RBC	4.92	0.21	4.69	0.34	4.86	4.53	4.41	4.55	4.42
Retic	1.0	0.1	1.6	0.4	1.3	1.5	1.5	1.5	2.1
Hb	14.2	0.5	14.3	0.1	14.1	13.1	13.0	13.1	12.8
Hct	42.1	0.8	42.3	0.6	43	38	38	39	39
WBC	4500	216	5000	458	5400	5500	5300	5500	4600
Neut	2387	552	2692	434	2754	2970	2650	2860	1610
Lymph	1607	367	2113	417	2106	1925	2279	2310	2484

Table VIII

HEMATOLOGY SUMMARY DATA

SUBJECT	PREBEDREST		BEDREST		POST BEDREST				
NO. 6	MEAN	S.D.	MEAN	S.D.	R+0	R+1	R+3	R+6	R+13
RBC	4.48	0.18	4.90	0.07	4.86	4.39	4.30	4.29	4.28
Retic	0.7	0.1	1.1	0.3	1.0	1.2	1.2	1.5	1.1
Hb	13.2	0.3	14.2	0.1	13.9	12.9	12.5	12.3	12.3
Hct	39.0	0.0	41.3	0.6	41	38	37	36	37
WBC	4200	216	5000	436	5100	5300	5200	4500	4200
Neut	1798	162	2251	340	2397	2597	2912	1845	1512
Lymph	2268	117	2554	327	2550	2544	2132	2520	2604

Table IX

RED BLOOD CELL CLASSIFICATION

	PREBEDREST Mean	PREBEDREST S.D.	BEDREST Mean	BEDREST S.D.	POST BEDREST Mean	POST BEDREST S.D.
Discocyte	82.52	5.52	73.86	6.75	72.92	7.55
Knizocyte	2.70	1.41	2.83	2.45	3.97	2.16
Stomatocyte	3.63	2.21	5.17	2.99	4.14	3.11
Spherocyte	7.86	4.82	10.86	4.69	11.68	5.00
Codocyte	0.53	0.83	1.53	1.76	1.64	2.08
Echinocyte	2.10	1.29	4.22	3.17	4.28	2.42

Table X

K FLUX IN RBC

	PREBEDREST		POST BEDREST	
	Mean	S.D.	Mean	S.D.
Total (Meq/L RBC/Hr)	1.88	0.35	1.89	0.48
Ouabain-Insensitive (Meq/L RBC/Hr)	0.53	0.13	0.45	0.06
Active (Meq/L RBC/Hr)	1.36	0.40	1.46	0.50
RBC K (Meq/L RBC)	101.00	6.13	99.91	3.85
Serum K (Meq/L)	4.19	0.25	4.19	0.22

Table XI

IMMUNOLOGY SUMMARY DATA

Subject No. 1	PREBEDREST		BEDREST		POST BEDREST			
	Mean	S.D.	Mean	S.D.	R+0	R+3	R+6	R+13
Protein	6.5	0	6.73	0.30	6.7	6.1	6.2	6.5
Albumin	4.13	0.11	4.06	0.32	3.6	3.7	3.8	3.2
A1-M	0.20	.00	0.20	.00	0.3	0.2	0.2	0.3
A2-M	0.50	0	0.53	.05	0.6	0.5	0.4	0.7
B-M	0.63	.05	0.63	.05	0.9	0.7	0.7	0.8
G-M	1.0	.05	1.3	.00	1.3	1.0	1.1	1.5
Transferin	357.66	12.5	296.33	57.35	273	258	249	311
Haptoglobin	103.33	2.3	112.33	10.01	96	97	106	110
Ceruloplasmin	27.00	2.6	34.33	2.88	32	25	25	28
A2-Macro	111.66	8.0	121.33	30.28	135	146	139	125
Immunoglobin								
IgA	137.00	7.81	132.00	10.58	146	142	159	143
IgG	1197.00	19.07	1061.00	83.13	1219	1197	1175	1231
IgM	111.66	9.29	113.33	16.50	135	133	139	126
IgD	6.0	0	6.33	0.577	5	6	6	7

Table XII

IMMUNOLOGY SUMMARY DATA

Subject No. 2	PREBEDREST		BEDREST		POST BEDREST			
	Mean	S.D.	Mean	S.D.	R+0	R+3	R+6	R+13
Protein	7.16	0.05	7.0	0.15	7.1	6.6	7.3	6.9
Albumin	4.50	0	4.23	0.15	4.1	4.3	4.6	3.7
A1-M	0.23	0.05	0.20	.00	0.3	0.2	0.2	0.3
A2-M	0.56	0.05	0.56	0.05	0.6	0.4	0.5	0.6
B-M	0.70	0	0.66	0.05	0.9	0.6	0.7	0.8
G-M	1.16	0.05	1.40	0	1.3	1.1	1.3	1.5
Transferin	320.33	2.30	254.66	37.31	273	266	261	228
Haptoglobin	100.33	8.14	102.00	0	94	102	106	91
Ceruloplasmin	24.66	1.15	31.00	5.56	30	29	30	27
A2-Macro	121.66	15.30	122.33	32.80	123	143	146	133
Immunoglobin								
IgA	153.33	5.13	167.66	24.58	199	175	159	149
IgG	1138.00	25.12	1005.33	33.60	1165	1242	1331	1109
IgM	103.66	4.04	99.33	3.51	121	121	139	130
IgD	5.66	0.57	5.0	0	6	5	5	5

Table XIII

IMMUNOLOGY SUMMARY DATA

Subject No. 3	PREBEDREST		BEDREST		POST BEDREST			
	Mean	S.D.	Mean	S.D.	R+0	R+3	R+6	R+13
Protein	7.03	0.20	7.16	0.05	7.1	6.6	6.7	6.6
Albumin	4.43	0.11	4.33	0.15	4.2	4.4	4.2	3.8
A1-M	0.26	0.05	0.26	0.05	0.3	0.2	0.2	0.3
A2-M	0.60	0	0.60	0.09	0.7	0.5	0.5	0.6
B-M	0.83	0.05	0.70	0	0.8	0.7	0.8	0.8
G-M	0.90	.00	1.26	0.05	1.1	0.8	1.0	1.1
Transferin	323.00	17.69	275.00	47.50	266	274	257	212
Haptoglobin	121.00	1.73	125.66	20.55	106	104	121	124
Ceruloplasmin	24.00	3.46	37.66	4.04	30	25	30	32
A2-Macro	104.33	3.51	113.00	17.34	146	150	145	133
Immunoglobin								
IgA	147.33	5.68	158.66	24.94	146	142	132	133
IgG	1058.33	33.29	939.00	45.03	1219	1264	1219	932
IgM	107.66	3.51	97.0	6.0	114	111	132	111
IgD	5.33	0.57	5.0	0	6	5	5	5

Table XIV

IMMUNOLOGY SUMMARY DATA

Subject No. 4	PREBEDREST		BEDREST		POST BEDREST			
	Mean	S.D.	Mean	S.D.	R+0	R+3	R+6	R+13
Protein	7.2	0.11	7.26	0.11	6.9	6.6	6.8	6.6
Albumin	4.43	0.28	4.36	0.20	4.6	4.3	4.5	3.8
A1-M	0.23	0.05	0.23	0.05	0.2	0.2	0.2	0.3
A2-M	0.63	0.05	0.60	0.10	0.5	0.5	0.5	0.6
B-M	0.80	0.00	0.70	0	0.7	0.7	0.7	0.8
G-M	1.13	0.05	1.36	0.05	0.9	0.9	0.9	1.1
Transferin	347.66	12.58	248.33	19.13	312	283	283	190
Haptoglobin	112.00	2.00	137.66	4.61	118	122	136	147
Ceruloplasmin	22.66	1.52	30.33	0.577	24	27	26	30
A2-Macro	128.66	9.07	113.00	17.57	136	120	132	132
Immunoglobin								
IgA	170.00	8.54	207.66	16.19	166	156	176	199
IgG	1186.0	33.00	987.00	68.69	1131	1098	1109	1131
IgM	118.33	2.51	95.66	11.59	125	114	104	120
IgD	6.66	0.57	5.0	0	5	5	5	6

Table XV

IMMUNOLOGY SUMMARY DATA

Subject No. 5	PREBEDREST		BEDREST		POST BEDREST			
	Mean	S.D.	Mean	S.D.	R+0	R+3	R+6	R+13
Protein	6.93	0.15	6.76	0.11	6.5	6.4	6.6	6.3
Albumin	4.26	0.3	4.03	0.25	4.2	4.1	4.2	3.6
A1-M	0.23	0.05	0.20	.00	0.2	0.2	0.2	0.2
A2-M	0.60	0.10	0.56	.05	0.5	0.5	0.6	0.6
B-M	0.76	0.05	0.70	0	0.7	0.7	0.7	0.8
G-M	1.0	0.11	1.26	0.11	0.9	0.9	0.9	1.1
Transferin	321.66	4.61	287.66	30.85	281	291	311	228
Haptoglobin	136.00	5.29	132.66	12.89	104	106	115	137
Ceruloplasmin	21.33	0.577	30.33	2.88	28	26	30	31
A2-Macro	156.33	10.50	121.66	21.12	139	117	113	126
Immunoglobin								
IgA	156.0	6.0	188.0	34.82	149	143	156	133
IgG	1123.66	25.40	961.0	128.17	1109	1109	1064	932
IgM	126.33	7.63	92.33	6.42	140	123	127	102
IgD	7.0	0	6.0	0	5	5	5	5

Table XVI

IMMUNOLOGY SUMMARY DATA

Subject No. 6	PREBEDREST		BEDREST		POST BEDREST			
	Mean	S.D.	Mean	S.D.	R+0	R+3	R+6	R+13
Protein	7.13	0.15	7.43	0.11	7.1	6.8	7	6.7
Albumin	4.36	0.25	4.26	0.05	4.5	4.2	4.2	3.8
A1-M	0.20	.00	0.23	0.05	0.2	0.2	0.2	0.3
A2-M	0.60	0.10	0.66	0.05	0.5	0.5	0.7	0.6
B-M	0.80	0.10	0.90	.00	0.8	0.9	0.9	0.8
G-M	1.16	0.05	1.36	0.05	1.1	1	1	1.2
Transferin	356.00	6.55	339.33	30.59	342	358	335	327
Haptoglobin	130.66	4.16	135.00	11.35	122	138	139	143
Ceruloplasmin	26.00	1.73	34.33	4.93	28	25	30	32
A2-Macro	134.33	7.57	113.00	17.57	132	136	136	114
Immunoglobin								
IgA	173.66	6.80	158.00	43.86	175	166	159	143
IgG	1042.00	19.06	990.66	111.72	1042	998	1219	1153
IgM	114.00	2.64	95.0	6.92	135	132	128	119
IgD	8.66	0.57	9.0	0	7	6	7	8

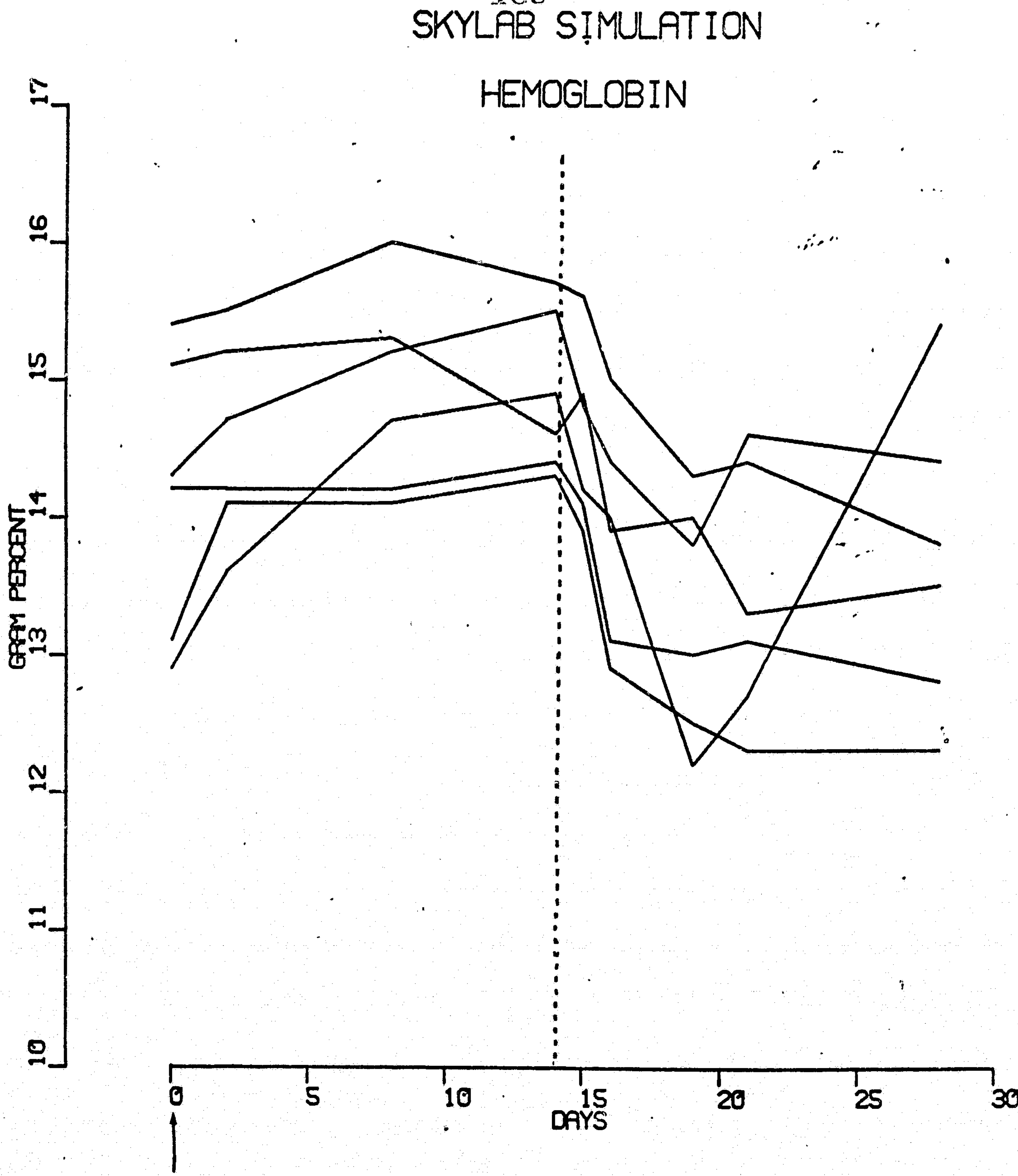

SKYLAB SIMULATION
HEMOGLOBIN
GRAM PERCENT
10
11
12
13
14
15
16
17
0
5
10
15
20
25
30
DAYS

Figure 1

SKYLAB SIMULATION

RETICULOCYTE COUNT

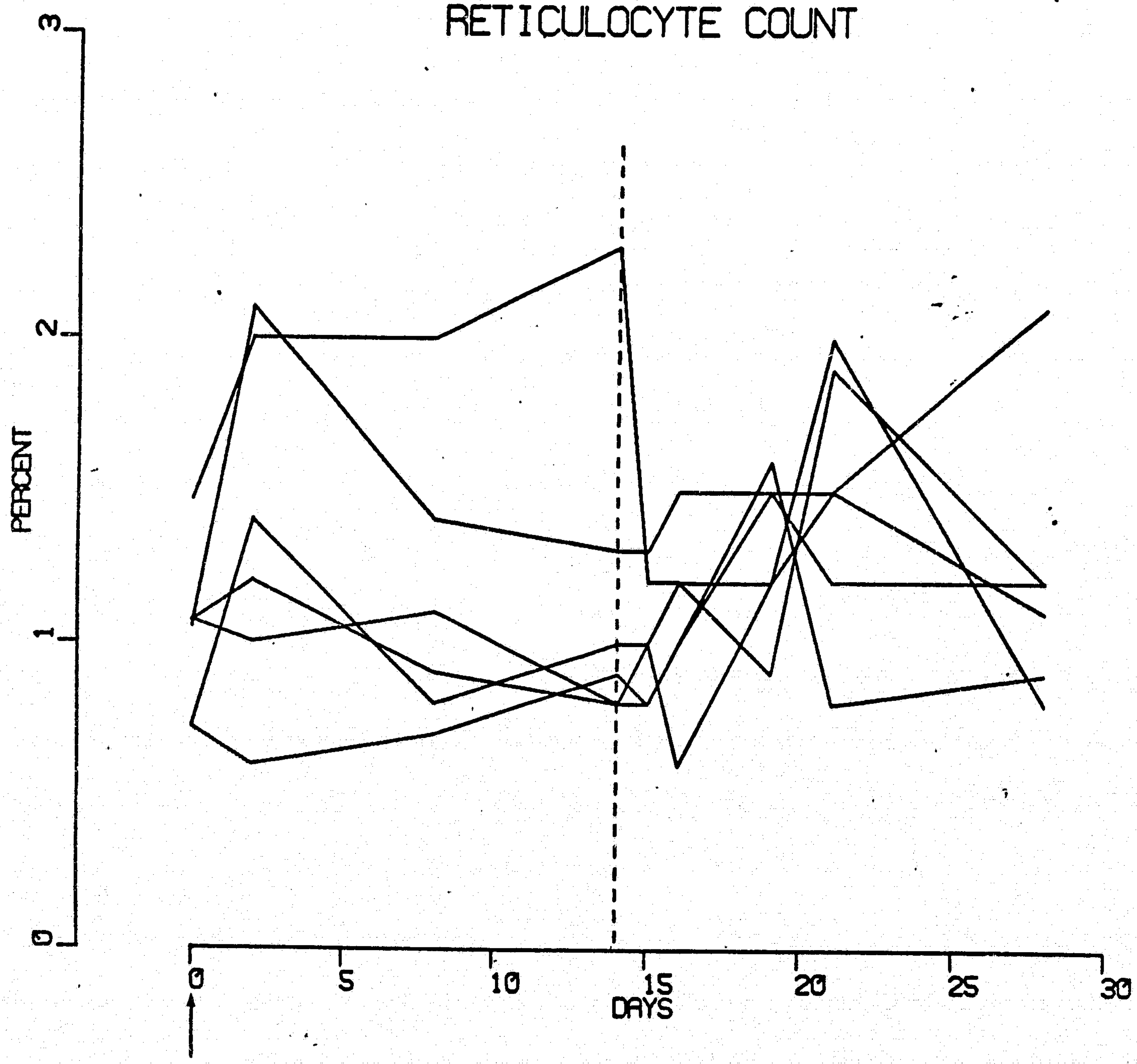


Figure 2

Cellular Immune Response of Six Healthy Subjects during Fourteen Days of Bedrest

B. Sue Criswell

Introduction:

The cellular immune response of six volunteers was studied before and after 14 days of bedrest. The findings from this study are to be correlated in the future with lymphocytic changes noted during the Skylab spaceflight. Briefly, the functional capacity of lymphocytes at splashdown of Skylab III and IV was depressed along with a suppression in the T lymphocyte numbers. No such changes were noted following bedrest for a 14 day period.

Methods and Materials:

Samples of heparinized peripheral venous blood (10 cc) were obtained and processed within 1 hr of collection. Before separation, total leukocyte (WBC) counts were performed using a hemacytometer and/or a Coulter Counter and differential counts were determined using slide preparations stained with Wright's Stain.

Lymphocyte Preparation:

Ficoll-Isopaque gradients. Lymphocytes were also separated by Ficoll-Isopaque gradient centrifugation according to the method of Boyum (1968). Cells in the resulting suspension of mononuclear cells were washed 3 times in MEM and then adjusted to a final concentration of 1×10^6 per ml.

Lymphocyte classification:

B lymphocyte distributions were determined by enumerating the percent of 200 mononuclear cells with surface immunoglobulins detected by immunofluorescent antibody technique described previously (DeFazio et al., 1975).

E rosette forming lymphocytes (T cells) were determined by the method of Jondahl et al. (1972). One x 10^6 lymphocytes were mixed in 0.25 ml MEM and added to 0.25 ml of a 0.5% sheep red blood cell (SRBC) suspension. After mixing, the tubes were incubated at 37°C for 5 min, then centrifuged at 500 g for 3 min, and incubated in ice water for 2 hrs. Approximately half of the supernatant was removed and the top layer of cells gently resuspended, 200 lymphocytes were counted with 3 or more adhering SRBC used as criteria for E rosetted lymphocyte.

Lymphocyte responsiveness in micro-culture to PHA, Pokeweed ~~(PW)~~ (PWM), and Concanavalin A (Con A):

Purified lymphocytes (1 x 10^5/ml) in minimum essential medium (MEM) containing 40% fetal calf serum (FCS) were placed in culture plates, and the antigens were diluted in MEM containing Pen-Strep and L-glutamine in the following concentrations: PHA - 0.01 ml/ml MEM, PWM - 0.01 ml and 0.05 ml/ml MEM, Con A - 25 μg and 50 μg/ml MEM. The diluted antigens in (0.1 ml) aliquots in duplicate

were placed in the appropriate well. The cultures were incubated in a humidified CO_2 atmosphere at 37^oC for 3 days for PHA and 5 days for Con A and PWM. On the day of harvest, samples were treated as described below for the influenza virus antigen cultures.

Lymphocyte responsiveness to influenza virus antigen by thymidine incorporation:

An inactivated monovalent type A influenza virus vaccine containing 1600 CCA units per ml of a Hong Kong strain (H3N2) was dialyzed against phosphate-buffered saline (PBS) and stored at -70^oC until used for tests. Separated lymphocytes were added in 0.1 ml aliquots in triplicate for each dilution of influenza antigen and the cultures incubated in a humidified CO_2 incubator at 37^oC for 1, 2, or 3 days. On the day of harvest, the cells were pulsed for 2 hours with 1 mCi of methyl ^3H-thymidine and then harvested with the MASH II automated harvester (Microbiological Associates, Bethesda, Maryland) onto glass fiber filter strips and then counted in a liquid scintillation counter (Packard Instruments, Downer's Grove, Illinois). Data were expressed as counts per minute (CPM) per 10^6 lymphocytes, and the stimulated index (SI) was calculated by dividing the mean result for stimulated cultures by that for the unstimulated cultures. Allantoic fluid was used separately as a control on reactivity of each individual to chick embryo proteins.

Results:

White blood cell quantitation:

Figure 1 shows the mean and one standard deviation of the white blood cell count on each perspective day pre and post-bedrest. No significant change was found on any occasion.

Lymphocyte classification:

Figure 2 shows the response of the total lymphocytic population in the peripheral blood. As seen, no changes occurred.

Figure 3 displays the results of the B lymphocytes which show fluctions during the bedrest period. Though still within the normal ranges for B cells (range 1.97-7.91) changes occurred the day prior to going to bed.

Figure 4 shows the T lymphocyte counts which did not change during the bedrest period.

Lymphocyte responsiveness in culture to PHA, PW, and Con A:

Table 1 shows the culture findings for the nonspecific mitogens. The stimulation indexes for all mitogens dropped at D + 0 and following the start of bedrest. PHA and Con A cultures showed the most significant changes with ~~PW~~ PWM cultures returning very rapidly to baseline levels. Even at the reduced levels of stimulation, however, these indexes still fall within normal ranges of stimulation.

Influenza virus antigen stimulation:

Two of the six volunteers responded to influenza virus antigen in cultures. These two subjects were positive on two separate days. Since this antigen is quite variable in response patterns even in known and diagnosed influenza illnesses, changes or losses in reactivity are not significant. Total lack of reactivity may reflect influenza susceptibility.

Discussion:

No statistically significant changes were found as a result of 14 days of bedrest in the cellular immune system of the six individuals. Trends were seen in the stimulation indexes toward a decrease in reactivity; however because of the rapid exchange of cells between different compartments in the body variation in the indexes may be expected.

It has been noted during spaceflight in Skylab IV that PHA responsiveness of lymphocytes was extremely depressed on splashdown. If bedrest is a simulation of zero gravity conditions, one might theorize that since no significant changes occurred in bedrest, then zero gravity may not have been the cause of the earlier lymphocytic changes. On the other hand, time in bed as time in space may be the important factor in initiating changes since both Skylab III and IV were longer than 14 days in duration.

Summary:

No significant changes occurred during 14 days of bedrest in the cellular immune response of 6 normal male volunteers. Perameters studied were WBC concentrations, lymphocyte numbers, B and T lymphocyte distributions in peripheral blood, and lymphocyte responsiveness to PHA, pokeweed, Concanavalin C, and Influenza virus antigen.

Table 1

Stimulation Indexes for Mitogens

Days of Analyses	PHA	PW-1 (0.01 ml/ml MEM)	PW-2 (0.05 ml/ml MEM	Con-A-1 (25 µg/ml MEM)	Con A-2 (50 µg/ml MEM
Pre-bedrest					
D-30	64 ± 23	30 ± 23	37 ± 23	117 ± 47	59 ± 48
D-15	74 ± 31	36 ± 15	23 ± 15	52 ± 30	59 ± 24
D-1	25 ± 25	79 ± 64	19 ± 25	56 ± 32	98 ± 112
Post-bedrest					
D+0	25 ± 20	17 ± 12	15 ± 10	16 ± 12	6 ± 6
D+3	22 ± 12	49 ± 22	23 ± 8	14 ± 10	9 ± 5
D+6	12 ± 13	24 ± 10	21 ± 10	6 ± 7	5 ± 4

Fig. 1

14 DAY BEDREST STUDY

MEAN WBC NUMBER

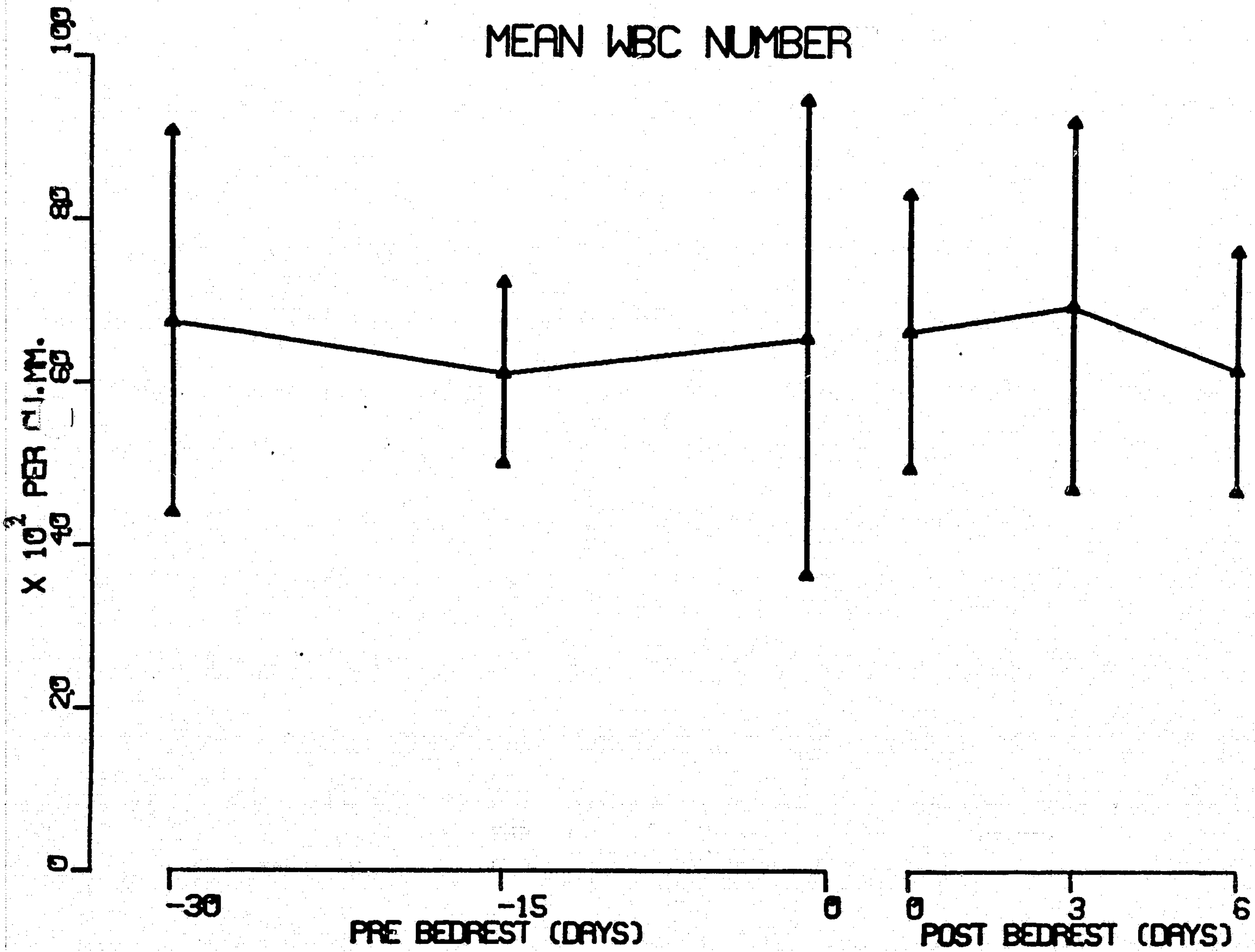


Fig. 2.

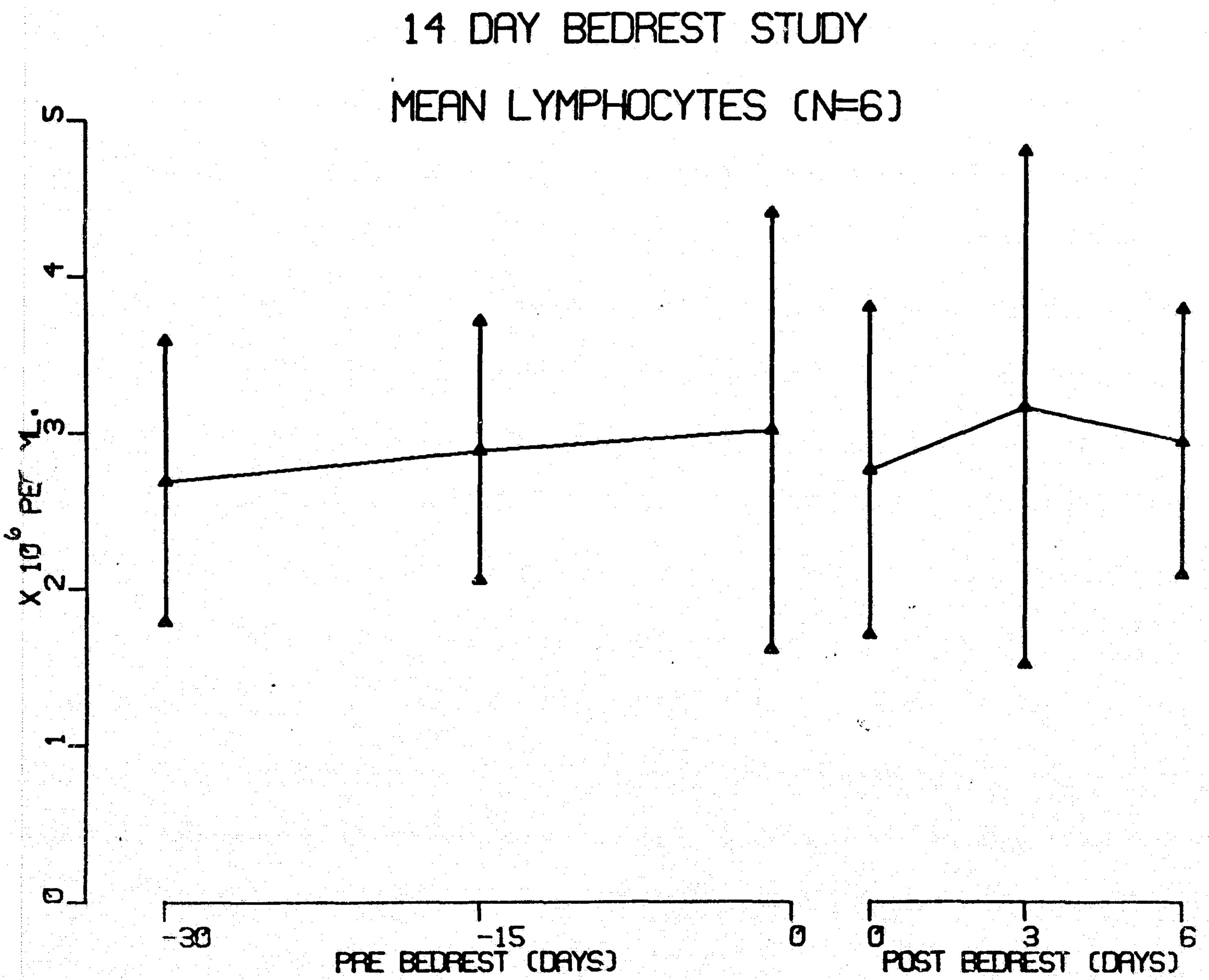

14 DAY BEDREST STUDY
MEAN LYMPHOCYTES (N=6)
X 10^6 PER ML.
0
1
2
3
4
5
-30
-15
0
PRE BEDREST (DAYS)
0
3
6
POST BEDREST (DAYS)

Fig. 3.

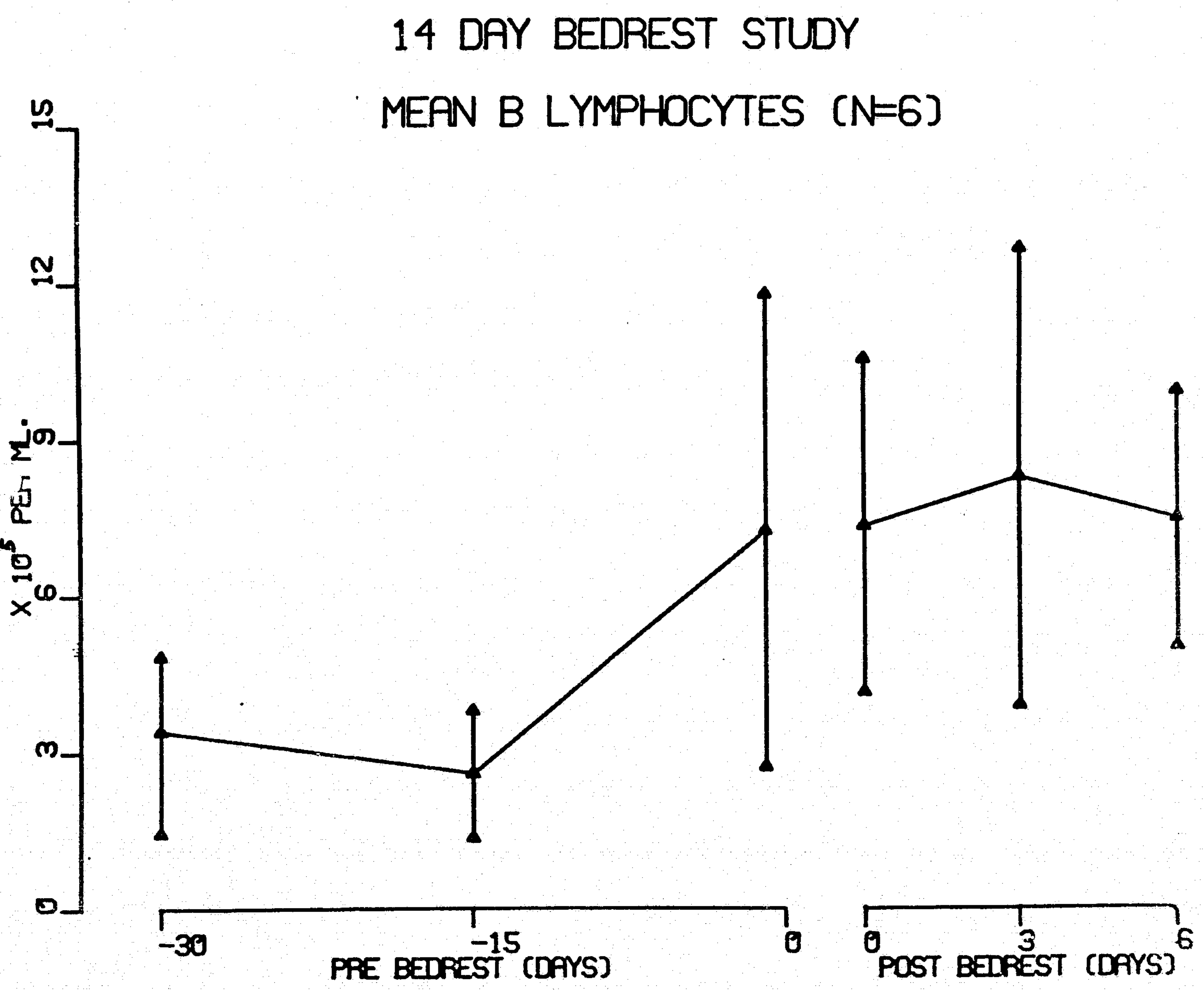
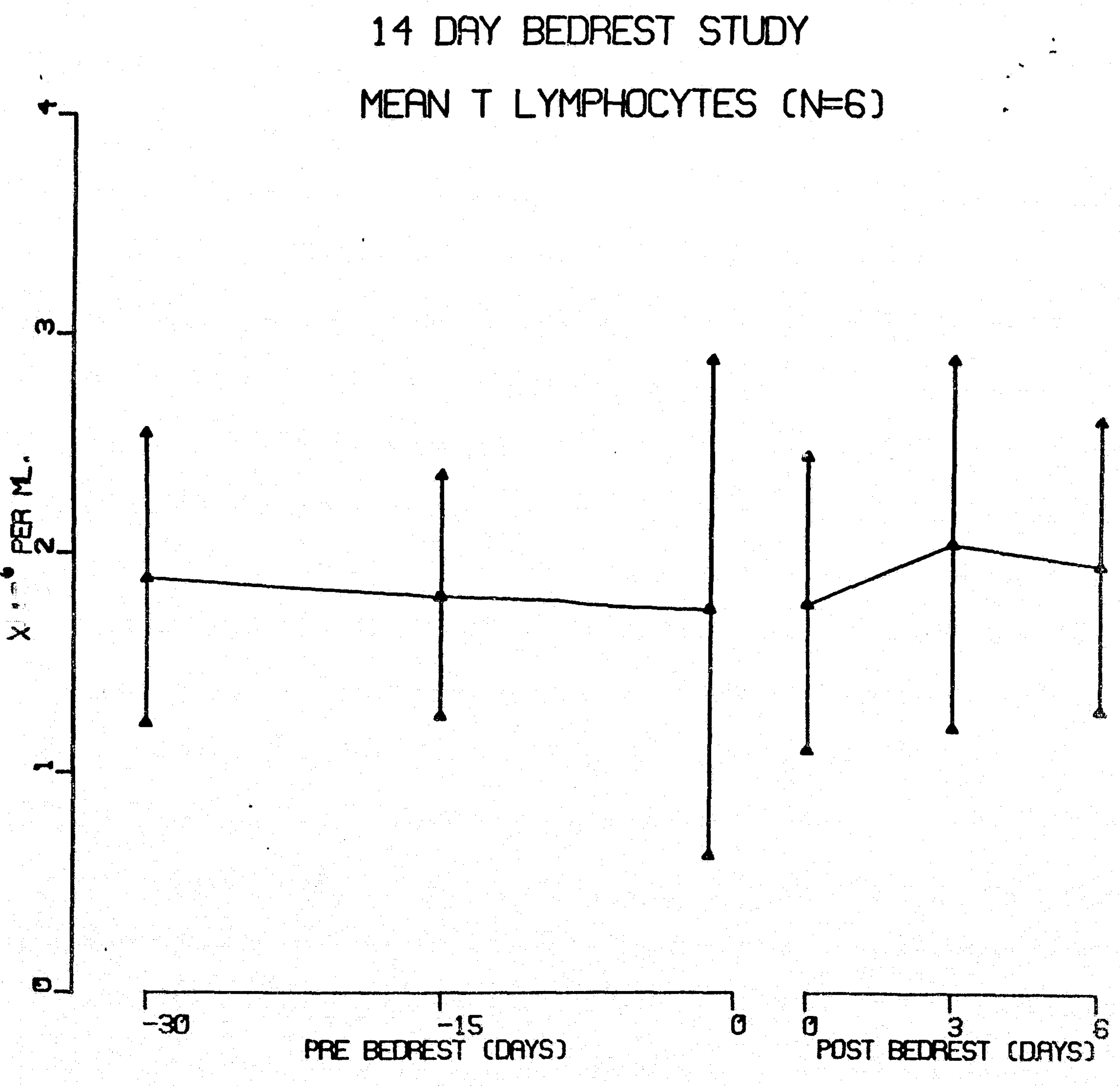

14 DAY BEDREST STUDY
MEAN B LYMPHOCYTES (N=6)
X 10⁵ PER ML.
0
3
6
9
12
15
-30
-15
0
PRE BEDREST (DAYS)
0
3
6
POST BEDREST (DAYS)

Fig. 4.


14 DAY BEDREST STUDY
MEAN T LYMPHOCYTES (N=6)
X 10⁻⁶ PER ML.
0
1
2
3
4
-30
-15
0
PRE BEDREST (DAYS)
0
3
6
POST BEDREST (DAYS)

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RED CELL MASS AND BODY VOLUME CHANGES AFTER 14 DAYS OF BEDREST

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When weighed postlanding, crew members of every spaceflight have lost body weight during their mission. Inflight measurement of crew members' body masses during Skylab indicates that the weight loss occurs relatively early. Space and volume studies of Apollo and Skylab crew members which compare premission values with postmission values indicate that the weight loss is both a loss of intracellular and extracellular fluid. These crewmen also showed a disproportionate loss of red cell mass for the plasma volume lost. (1,2) The mean values from the Apollo crews 14-17 are a typical demonstration of this phenomena (Table 9).

Happily these changes are reversed during a relatively short postmission recovery period, although residual changes may last a month or more. Further study of this fluid and tissue loss should help determine if counter measures are indicated for future flights; and from these studies, the physiology of these rapid changes in fluid volume might be determined.

The most readily available biological simulation of a period of weightless flight appears to be a period of bedrest in which the subjects are not allowed to stand upright during

the study period. Bedrest reproduces many of the cardiovascular changes found in returning crew members, and it seems to reproduce the calcium loss associated with spaceflight.

A two-week bedrest (BR) study has been completed which attempted to reproduce most of the testing conditions of Skylab and the last Apollo mission. While this study did not reproduce many mission stresses experienced by the crews, it did faithfully follow pre- and postflight medical testing profiles so that direct comparison of the bedrest study results can be made with the medical results from the Skylab and Apollo missions.

METHODS

A brief history and physical for each of the six subjects and a description of the general experimental design are given in the introduction. The food intake was designed to maintain body weight. Total daily calories exceeded those consumed by the crew members of many Apollo missions but were not greater than the caloric intake of Skylab crew members. Electrolyte intake was regulated as in Skylab producing a metabolic balance study.

Table 1 contains a listing of the radionuclides used for these space and volume studies, the dose administered and the radiation exposure produced. Table 2 gives the study day each test was performed. The schedule in Table 2 was designed to reproduce the protocol used for the Skylab crew members. The

technics for radionuclide determinations have been described previously. (2) The exact blood sampling schedule and the amounts of blood drawn are shown in Table II of Dr. Kimzey's (M110) hematology report. Shown in Tables 3 and 4 are the results of the space and volume determinations made on the bed-rested subjects. At the end of the bedrest study the total body water (TBW), extracellular fluid (ECF) and iron turnover doses were given on the 13th day in the morning (7:00 AM) with the subjects fasting. The subjects remained at bedrest for 24 more hours before the start of the medical testing which included red cell mass (RCM), plasma volume (PV) and total body exchangeable potassium (TBEK). Additional details of these studies are available in Dr. Leach's report since the space and volume studies are an integral part of MO70.

At the completion of an Apollo or Skylab mission, blood was drawn at recovery after greeting ceremonies on deck for the returning crew members. The crew members had been awake for 8-12 hours performing reentry and recovery chores. They generally had eaten breakfast 4-9 hours before the testing. The crew members remained quietly recumbent for 30 minutes before the volume and space studies and for the 30 minute equilibrium time of the PV, RCM and ECF. After these measurements, the crew members were allowed to be up and about and to begin lower body negative pressure (LBNP) and bicycle ergometry. The doses for TBW and TBEK were given at the same time as the other radionuclides but require 4-6 hours for TBW and 24-48

hours for TBEK prior to equilibrium.

The major difference between the space and volume studies postbedrest from those postspaceflight is the amount of stress the men were subjected to. The PV and RCM were determined for the bedrested subjects immediately upon awakening after an overnight sleep and the equilibrium period for the TBW, ECF and iron turnover did not include the vascular stresses of upright posture, LBNP and bicycle ergometry.

RESULTS

Tables 3 through 6 show the results of the space and volume studies. Tables 7 and 8 show the percent change for each subject and the mean percent change during the study. Percent change in these studies is defined as the change in the value compared to the control value 21 days prior to bedrest.

At the end of bedrest red cell mass had decreased 4.9%. This was less than the 6.9% decrease in plasma volume. Extra-cellular fluid mean decrease was 1.3%. All other values including weight showed less than a 1% change. Only the red cell mass and plasma volume changes are statistically different from zero. It can be seen that red cell mass continued to decrease during the first two weeks of ambulation. This is in contrast to the plasma volume which increased during that

period. By 48 days postbedrest plasma volume had returned to the prebedrest value while the red cell mass had increased to above the initial value.

Table 9 compares these mean percent changes with the mean percent changes obtained for the crew members of some Apollo missions. There are significant differences between the two situations with the greater change associated with spaceflight.

DISCUSSION

This bedrest study which lasted 14 days was designed to partially simulate conditions associated with the Skylab missions. Some differences between bedrest and spaceflight are obvious such as the lack of weightlessness and acceleration stress in bedrest. The similarities include the Skylab diet, electrolyte intake, metabolic balance conditions, and similar pre- and postmission medical studies. There are other not so obvious differences. For example, no planned exercise was performed during bedrest so that the work load of mission activities was not simulated. The hypobaric atmosphere of Apollo and Skylab was not simulated nor was the hyperoxic atmosphere of the Apollo command module. The beginning of bedrest is not associated with the stomach awareness and nausea felt during the first few days of weightless flight. Therefore, voluntary caloric restriction did not occur during

the first few days of the bedrest study, while caloric restriction is a constant feature of a crewman's early response to spaceflight.

The bedrest study did not attempt to change the circadian rhythms of the subjects while most space missions are required to change the day-night cycle to guarantee favorable landing conditions at the end of the mission. In general, the subjects were one decade younger than the astronauts. Otherwise they were of similar size and relative weight.

Spaceflight obviously causes a loss of body tissues as is shown by the decrease in weight, TBW, ECF, PV and RCM of the crew members. (1) The decrease in total body water is too large to be accounted for by only the extracellular fluid loss. The 2.7% decrease in ECF would account for only a 1% decrease in TBW or about one-third of the measured loss. This occurs even though the diet is adequate as far as the crew members are concerned. No evidence of tissue loss other than the red cell mass was noted in the subjects of this bedrest study. These findings are consistent with other bedrest studies which show that weight loss does not occur generally. Some bedrest studies have used exercise programs during the period of bedrest. It is probable however that the caloric cost of these inbed exercise regimes is considerably below the caloric cost of spaceflight activities.

The cause of the red cell mass loss of spaceflight is still unknown. The loss in Skylab approximated that of Apollo with a mean red cell mass loss of 11.1 ±1.7%. (2) However, the various Skylab missions differed considerably with the least RCM change found after the longest mission. Red cell mass had not been determined often after bedrest using a red cell tracer so the evidence that bedrest causes a red cell mass decrease is scanty. (3-5) Morse in a study of Air Force volunteers found a mean RCM decrease of 9.3% at the end of 35 days of bedrest and a loss 1/3 that large after a 24-day bedrest. (3) Saltin found a 6.2% decrease in red cell mass in subjects bedrested for 20 days. (5) In a 6-day bedrest study we found a 2.4% mean decrease in red cell mass. These means are consistently less than the mean change after spaceflight.

SMEAT, a 56-day project including a 5 psi atmosphere, was designed to reproduce the environment of Skylab, but it did not include weightlessness or bedrest. The three crew members performed the same type of studies and with the same equipment used in Skylab. Red cell mass loss of 2.7±0.4% occurred with mean weight loss of 3.7 ±2.0%.

In this study the mean red cell mass decrease was greater 13 days after bedrest (-6.5%) than it was at the end of bedrest (-4.9%). It has been noted by others that the exercise

during the postbedrest period causes a further decrease in red cell mass. (7) It has been postulated that red cells are regularly destroyed during exercise. Presumably the lack of exercise during bedrest conserves fragile red cells which are more vulnerable to destruction during the early ambulation period. Additional decreases in red cell mass have not been found during the first two weeks following return of the astronauts. (2,8) Whether this indicates that a different process is operable in the spaceflight induced red cell mass loss with exercise during flight being great enough to destroy vulnerable cells, or whether an additional decrease in red cell mass occurred between the ocean landing and the time when the red cell mass was measured as it did when we ambulated these bedrested subjects is unknown since the time course of the observed spaceflight red cell mass decrease is unknown.

While the red cell mass decrease in bedrest seems less than that of spaceflight, this is not true of plasma volume. Generally, plasma volume decreases 10% after several days of bedrest and continues to decrease slowly thereafter to plateau at about -20%. (9) The 6.9% decrease found in this study while less than that found in many other bedrest studies is still greater than the 4.4% mean decrease of the Apollo crew members. (8) Aldosterone, a known plasma volume expander, is generally higher during spaceflight than before the premission control

period and also higher during the mission than in bedrest. The Skylab diet has a high salt content. Either factor may have affected the plasma volume by counteracting bedrest type decreases during the spaceflight. Dr. Leach has found that unlike some other bedrest studies, aldosterone levels in the subjects' plasma and urine during the bedrest period was higher than it was during the control prebedrest period. The higher aldosterone levels may have prevented even greater drops in plasma volume.

Another reason plasma volume does not show a greater decrease during spaceflight could be a result of the low atmospheric pressure of the Skylab and Apollo environment. The low gas pressure would impede body heat loss by convection. In SMEAT, the Skylab simulation, mean plasma volume increased 2.8% probably reflecting the heat loss difference between 5 and 15 psi. (6) The 2.8% increase subtracted from the mean decrease of Apollo would produce a 7.2% loss which more closely approaches the predicted 10% decrease of similar time periods at bedrest and very closely approximates the 6.9% decrease found in this study.

TBW and TBEK loss measured in the crew members returning from spaceflight did not occur in the subjects of this bedrest study, and ECF decreased a mere 1.3%. However, other bedrest studies have been associated with larger decreases in extracellular fluid. Hyatt et al. found negative fluid balance in

bedrest and noted that ECF decreases were found in the study of Vogt. (10,11) These authors postulated that the orthostatic cardiovascular sensitivity noted postbedrest could be a result of extravascular dehydration in response to the lack of gravity parallel to the long axis of the body during bedrest. Orthostatic sensitivity was noted in the subjects of this bedrest study; yet, the ECF changes were statistically not significant. This 14-day study agreed with the result of a six-day study in which no change in ECF occurred; yet, orthostatic intolerance was present in both. Certainly, the ECF loss of bedrest appears less than after spaceflight; yet, the changes found during lower body negative pressure and during bicycle ergometry show similar degrees of orthostatic intolerance. Therefore, ECF dehydration does not seem to be the major cause of the orthostatic intolerance noted after bedrest.

SUMMARY

This 14-day bedrest study was designed to be similar to Apollo 17 which included the Skylab diet and modified metabolic balance and was of similar duration. The same equipment and procedures used in the crews pre- and postflight medical examinations were used in this bedrest study so that comparisons are possible between the results of each.

The subjects of this bedrest study did not show weight loss. Only a small, transient weight loss was seen during the first few days of bedrest and even this did not approach the magnitude of the weight loss of crew members returning from spaceflight. The mean red cell mass decrease during bedrest was less than the mean change in Apollo and Skylab crew members while the plasma volume change was greater. No statistically significant change occurred in ECF, TBW and TBEK.

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TABLE 1

Nuclide	Dose/ Test	$T_{1/2}$ Eff	Physical Form	rem/µCi Critical Organ	rem/µCi Total Body	Total µCi*	Total Body (rem)
^{125}I	2 µCi	30	Albumin	Thyroid - 0.06-0.2	0.00050	10	0.005
^{51}Cr	25 µCi	28	Chromate	Spleen - 0.004	0.00036	100	0.036
^{35}S	25 µCi	44	Sulfate	Total Body - 0.00009	0.00009	75	0.007
^{3}H	25 µCi	12	Water	Total Body - 0.00017	0.00017	75	0.012
^{43}K	50 µCi	1	Chloride	Muscle - 0.00094	0.00062	100	0.062
^{59}Fe	2 µCi	45	Citrate or Chloride	Spleen - 0.24	0.035	2	0.070
							0.192

*Total for Prebedrest and Postbedrest Determinations

Maximum permissible total body occupational exposure is 1.25 rem/quarter.

This can be increased to 3.0 rem/quarter if total for the year is less than 5.0 rem.

TABLE 2

RADIONUCLIDE ADMINISTRATION SCHEDULE

	Prebedrest	Bedrest		Postbedrest		
Days	21	2	13	0	14	48
Plasma Volume	X	X		X	X	X
Red Cell Mass	X			X	X	X
Extracellular Fluid	X		X		X	
Total Body Water	X		X		X	
Total Body Exchangeable Potassium	X			X		
Iron Turnover			X			

TABLE 3

Subjects	1	2	3	4	5	6
			RCM (ml)			
BR -21	1821	1905	2230	1889	1744	1709
BR +14	1777	1890	2058	1779	1632	1600
R +13	1701	1899	1975	1794	1584	1599
R +48	2067	1913	2417	1967	1774	1760
			PV (ml)			
BR -21	3280	3096	3168	2583	2848	3071
BR + 1	3115	3229	3023	2646	2813	2993
BR +14	2644	3060	2940	2560	2711	2836
R +13	3292	3102	3591	2920	3198	3224
R +48	3063	3038	3114	2849	2832	3206
			TBW (L)			
BR -21	43.0	43.2	43.4	41.4	44.8	39.7
BR +14	42.1	43.1	43.4	41.8	44.1	40.5
R +13	46.5	43.3	44.4	41.3	45.0	40.5
			ECF (L)			
BR -21	16.9	16.3	18.2	14.6	17.0	15.0
BR +14	16.0	16.3	17.1	14.7	16.8	15.6
R +13	15.9	16.5	17.1	15.2	16.7	15.4
			ICF (L)			
BR -21	26.1	26.9	25.2	26.8	27.8	24.7
BR +14	26.1	26.8	26.3	27.1	27.3	24.9
R +13	30.6	26.8	27.3	26.1	28.3	25.1
			ISF (L)			
BR -21	13.6	13.2	15.0	12.0	14.2	11.9
BR +14	13.3	13.2	14.2	12.2	14.1	12.8
R +13	12.6	13.4	13.5	12.3	13.5	12.2

TABLE 4

Subjects	1	2	3	4	5	6
			Red Cell Mass (ml/kg)			
BR -21	26.5	26.8	32.1	26.8	29.2	21.2
BR +14	25.7	26.6	29.4	24.4	27.5	19.9
R +14	24.3	26.9	28.5	24.4	28.3	19.8
R +48	29.4	27.2	35.2	27.7	29.9	21.4
			PV (ml/kg)			
BR -21	47.8	43.5	45.6	48.2	40.0	34.6
BR + 1	44.9	45.2	43.9	46.5	41.7	34.9
BR +14	38.3	43.2	42.0	43.2	39.6	33.1
R +13	47.1	43.9	51.9	49.2	46.1	40.1
R +48	43.5	43.2	45.4	50.4	43.3	34.2
			TBW (ml/kg)			
BR -21	627	607	624	623	640	544
BR +14	609	608	620	618	646	538
R +13	665	613	642	618	652	564
			ECF (ml/kg)			
BR -21	246	229	261	235	226	206
BR +14	232	230	244	237	227	205
R +13	227	234	247	235	240	209
			ICF (ml/kg)			
BR -21	380	378	362	388	415	338
BR +14	378	378	376	379	419	333
R +13	438	380	394	383	413	355
			ISF (ml/kg)			
BR -21	198	185	216	187	186	173
BR +14	192	186	203	195	188	172
R +13	180	189	195	186	194	169

TABLE 5

Subjects	1	2	3	4	5	6
			Exchangeable TBK (meq)			
BR −21	3742	3666	3572	3573	4027	3171
BR +14	3670	3552	3630	3668	3942	3091
			Exchangeable TBK (meq/kg)			
BR −21	54.5	51.5	51.4	55.3	48.9	49.8
BR +14	53.1	50.1	51.8	56.7	48.1	47.0
			LBM (kg)			
BR −21	58.9	59.2	59.4	56.7	61.4	54.4
BR +14	57.7	59.0	59.4	57.2	60.4	55.5
R +13	63.7	59.3	60.8	56.6	61.6	55.5
			LBM (% BW)			
BR −21	85.9	83.1	85.5	87.7	74.6	85.4
BR +14	83.5	83.2	84.8	88.4	73.6	84.5
R +13	91.1	84.0	87.9	89.4	77.2	84.7
			Wt (Kg)			
BR −21	68.6	71.2	69.5	64.6	82.3	63.7
BR +14	69.1	70.9	70.0	64.7	82.0	65.7
R +13	69.9	70.6	69.2	63.3	79.8	65.5
R +48	70.4	70.4	68.6	65.8	82.8	63.6

TABLE 6

Subjects	1	2	3	4	5	6
Peripheral Hct						
BR -21	40	44	47	48	41	40
BR +14	45	44	47	46	42	41
R +13	39	44	42	42	38	38
R +48	47	45	50	46	44	40
Total Body Hct						
BR -21	36	38	41	42	38	36
BR +14	40	38	41	41	38	36
R +13	34	38	36	38	33	33
R +48	40	39	44	41	39	35
Ratio						
BR -21	0.90	0.86	0.87	0.88	0.92	0.90
BR +14	0.89	0.86	0.87	0.89	0.90	0.88
R +13	0.87	0.86	0.86	0.90	0.87	0.87
R +48	0.85	0.87	0.88	0.89	0.89	0.88
Serum Iron (μg%)						
BR +14	120	71	131	108	93	119
Iron Turnover Rate (mg/kg/day)						
BR +14	0.31	0.67	0.33	0.39	0.45	0.33
Fe Plasma $T_{1/2}$ (min)						
BR +14	148	45.5	167	108	84.5	126
% Fe Reappearance in Red Cells						
Day 1	10	19	11	12	19	18
3	43	60	38	63	60	48
6	87	96	66	91	92	90
13	100	94	71	104	97	102
^{51}Cr Survival (days)						
Pre	23	23	30	23	23	28
Post	25	20	24	24	23	26

TABLE 7

	Mean	Subjects 1	2	3	4	5	6
PERCENT CHANGE							
RCM (ml)							
BR +14	95.1	97.6	99.2	92.3	94.2	93.6	93.6
R +13	93.5	93.4	99.7	88.6	95.0	90.8	93.6
R +48	105.2	113.5	100.4	108.4	104.1	101.7	103.0
PV (ml)							
BR + 1	97.2	95.0	104.3	95.4	102.4	98.8	97.5
BR +14	93.1	80.6	98.8	92.8	99.1	95.2	92.3
R +13	107.4	100.4	100.2	113.4	113.0	112.3	105.0
R +48	100.6	93.4	98.1	98.3	110.3	99.4	104.4
TBW (L)							
BR +14	99.7	97.9	99.8	100.0	100.1	98.4	102.0
R +13	102.1	108.1	100.2	102.3	99.8	100.4	102.0
ECF (L)							
BR +14	98.7	94.7	100.0	94.0	100.7	98.8	104.0
R +13	99.0	94.1	101.2	94.0	104.1	98.2	102.7
ICF (L)							
BR +14	100.7	100.0	99.6	104.4	101.1	98.2	100.8
R +13	104.3	117.2	99.6	108.3	97.4	101.8	101.6
ISF (L)							
BR +14	100.2	97.8	100.0	94.7	101.7	99.3	107.6
R +13	97.4	92.6	101.5	90.0	102.5	95.1	102.5
TBEK (mEq)							
BR +14	99.1	98.1	96.1	101.6	102.6	97.9	97.5
Wt							
BR +14	100.6	100.7	99.6	100.7	100.2	99.4	103.1
R +13	99.8	101.9	99.2	99.6	98.0	97.0	102.8
R +48	100.4	102.6	98.9	98.7	101.8	100.6	99.8

TABLE 8

		Subjects					
	Mean	1	2	3	4	5	6
PERCENT CHANGE							
RCM (ml/kg)							
BR +14	94.5	97.0	99.2	91.6	94.2	93.9	91.0
R +13	93.7	91.7	100.4	88.8	96.9	93.4	91.0
R +48	104.7	110.9	101.5	109.6	102.4	100.9	103.4
PV (ml/kg)							
BR + 1	99.3	93.9	103.9	96.3	104.2	100.9	96.5
BR +14	92.6	80.1	99.3	92.1	99.0	95.7	89.6
R +13	107.7	98.5	100.9	113.8	115.2	115.9	102.1
R +48	100.2	91.0	99.3	99.6	108.2	98.8	104.5
TBW (ml/kg)							
BR +14	99.3	97.1	100.1	99.4	100.9	98.9	99.2
R +13	102.5	106.1	101.0	102.9	101.9	103.7	99.2
	101.7						
ECF (ml/kg)							
BR +14	98.2	94.3	100.4	93.5	100.4	99.5	100.8
R +13	99.4	92.3	102.2	94.6	106.2	101.4	100.0
ICF (ml/kg)							
BR +14	100.1	99.5	100.0	103.9	100.9	98.5	97.7
R +13	105.1	115.3	100.5	108.8	99.5	105.0	101.3
	103.0						
ISF (ml/kg)							
BR +14	99.4	97.0	100.5	94.0	101.1	99.4	104.3
R +13	97.8	90.9	102.2	90.3	105.9	97.7	99.5
TBEK (mEq/kg)							
BR +14	99.8	98.0	99.7	100.0	100.9	98.4	102.0

TABLE 9

MEAN PERCENT CHANGE AT END OF MISSION AND BEDREST*

	Apollo	14-Day Bedrest
Red Cell Mass	-10.1 ±1.3	-4.9 ±1.1
Plasma Volume	- 4.4 ±1.7	-6.9 ±2.8
Total Body Water	- 2.4 ±0.4	-0.3 ±0.6
Extracellular Fluid	- 2.7 ±1.0	-1.3 ±1.6
Intracellular Fluid	- 2.1 ±0.8	+0.8 ±0.8
Body Weight	- 3.9 ±0.5	+0.6 ±0.5

*Mean ± Standard Error.

Biochemical Results

Carolyn S. Leach

The biochemical studies were initiated to determine whether extended bedrest produces similar biochemical changes as noted in samples returned from Skylab flights (first 14 days) and whether final effects are similar to those observed in returning Apollo crewmen.

Although numerous bedrest studies have been completed, each study has been designed around a specific area to answer a specific question. These very necessary studies have produced large volumes of data about a particular body system response to a certain period in bedrest. However, the type of results produced by these studies has not made the comparison of bedrest findings to space flight results possible. In every case, the biochemical results of the space flight crewmen include not only the response to the exposure to weightless flight, but also the biochemical responses to stress, fatigue, and numerous physiological stress test. For these reasons, it was considered important to conduct this study to more closely simulate the actual space flight experience.

Experimental Protocol and Methods

The control portion of this experiment began 21 days prior to the test, continued throughout the 14 days of bedrest, and 14 days after completion of test. Pre- and post urine and fecal collections were accomplished wherever the subjects were residing at that time. During the collection, the urine specimens were cooled at 4°C. Each morning the urine collected during the previous day was received in its cooled state at the laboratory where it was stabilized. The in-bed collections were maintained in a similar manner.

Complete fecal collections were undertaken. Fecal samples were frozen and then dehydrated in preparation for analysis.

The metabolic monitoring period also included the rigid control of dietary intake. All foods were analyzed for major nutrients and the intake of sodium, potassium, chloride, magnesium, nitrogen, and calcium was controlled within narrow limits through the design of repetive menu cycles to which the subjects were required to adhere throughout the experimental period. In Table 1 are listed the mean sodium and potassium intake values for all subjects.

For this experiment, fasting blood samples were drawn 30, 21, 7, and 1 day before the test at approximately 7:00 a.m. Samples drawn during the bedrest on days 2, 7, and 13 were also drawn with the subjects fasting and at about 7:30 a.m. Blood samples were drawn immediately after bedrest and 1, 3, and 14 days later. For this experiment, the blood volumes for pre-bedrest and post-bedrest analyses were 25 ml and the in-bedrest plasma averaged 3 ml. Sodium EDTA was used as the anticoagulant.

Methodology for the more routine clinical biochemical tests was that in standard use in laboratory medicine. For the more involved hormonal analyses, radioassay, fluorometric, and gas chromatographic methodology was employed. The measurement of various body compartments was conducted pre- and post-bedrest utilizing the principle of isotopic dilution. Total body water was estimated with tritium, extracellular fluid with sodium sulfate containing ^{35}S, plasma volume with protein labeled with ^{125}I, and potassium with ^{42}K.

Since individual variation among normal men has been constantly observed during previous programs, each man served as his own control; his in-bedrest and post-bedrest data were compared with his pre-bedrest controlled phase. The pretest value each time is given as a mean of the entire control period as well as individual values.

Results

In the presentation of results, the mean value of each parameter for each crewman measured prior to flight is compared with that same parameter measured inflight and postflight. In Tables 2 and 3 are presented the results of analyses performed on plasma and serum samples. In-bedrest and post-bedrest values differing statistically from corresponding measurements performed pretest are indicated ($P \leq 0.05$).

Glucose was decreased the last day in bed (R+0) on two of the subjects, by R+1 the values had returned to normal. The cholesterol, SGOT, BUN, uric acid, calcium, magnesium, biliriubin, creatinine, osmolality, sodium, potassium, chloride and triglyceride results were variable. Alkaline phosphatase and phosphorous values were slightly higher on R+0, whereas LDH and CPK results were slightly lower on R+0.

Angiotensin I (Renin Activity) was decreased on the second day at bedrest and then increased. It was generally increased at R+1. (The first day up). Three of the six subject had increased insulin on R+0 day. Cortisol was variable, but generally decreased during bedrest. Aldosterone was decreased during bedrest and elevated post-bedrest. Thyroxine was generally elevated the last day in bed.

Those constituents of the 24-hour urine sample which were changed during and after bedrest are shown in Tables 4 and 5. Osmolality results were variable with time showing early increases then decreases. Volume, sodium, potassium, chlorine, calcium, magnesium, phosphorous, uric acid, cortisol, and aldosterone showed overall increases during bedrest. Hydrogen ion, epinephrine, norepinephrine, and antidiuretic hormone all showed decreases during bedrest. Post bedrest, overall decreases were observed in osmolality, sodium, potassium, chloride, calcium epinephrine, while increases were shown in magnesium, phosphorous, uric acid noreprinephrine and aldosterone.

The results of the pre- and post-bedrest analysis of total body water, extracellular fluid and exchangeable potassium are shown in Table 6. The results are variable but show slight decreases in most subjects during bedrest in all 3 measurements.

Table 7 gives the mean body weights for all three subjects each period of the study. Only slight increases are observed in 2 subjects during and post-bedrest.

Discussion

The biochemical changes caused by bedrest are well documented in the electrolyte area; however, the endocrine studies conducted during bedrest experiments have been limited. Major emphasis has been placed on the skeletal and cardiovascular reaction to the hypokinetic environment in studies of varying duration due to the clinical findings in these areas. In reviewing the studies that have been conducted, it is obvious that the changes which occur in the human body at bedrest are documented.

It remains to study these changes in a protocol more realistic to actual space flight mission activities. This study was conducted to simulate a 14 day space flight without significant exercise. The biochemical findings are discussed in relation to postflight Apollo results and to the first 2 weeks of Skylab.

It has been previously demonstrated that exposure to weightlessness results in a redistribution of the volume of blood within the vascular system. This redistribution is interpreted as an increase in blood volume by stretch receptors in the left atrium, thus causing a compensatory loss in water, sodium and potassium from the renal tubules. This loss in water has been manifested after every space flight as a loss in body weight, most of which is rapidly regained on the first post-bedrest day. It should be pointed out, however, that some of this body weight loss is not regained and is though to be comprised of both fat and proteinaceous material. The decreased adiposity has been attributable to a hypocaloric food intake, while the loss in the elemental constituents of the musculoskeletal system appears to be a more direct consequence of reduced compressional and tensile forces.

Apollo crewmen showed weight losses which averaged 6 pounds or 3.5% mean weightloss. Body weight changes are not characteristic of bedrest, in fact, care must be taken to prevent weight gain during the bedrest phase. The subjects in this study (Table 7) did not lost weight, two actually gained slightly during bedrest.

A comparison of urine volume and sodium excretion in the 9 Skylab crewmen and the 6 subjects of this bedrest shows sodium excretion elevated in both groups about the same from control values. The differences in the magnitude of the sodium changes appear in days 2-7 in Skylab. This is the same period when the intake was generally decreased in those crewmen. Twenty-four hour urine volumes are elevated the first two days of bedrest, but not in space flight. With the exception of this initial period, subsequent 24 hour urine volumes were not significantly different from those obtained pre- and post-bedrest.

Urinary ADH showed an overall elevation on 4 out of the first 5 days in bedrest. It was decreased on day 3.

The pre- and post bedrest analysis of total body water and extracellular fluid did not reveal significant changes. Considering the environment control, the lack of stress and the diminished exercise during the bedrest phase these results are not unexpected. It is important to note a slight decrease in all subjects. These data again show the same direction but different magnitude than the space flight results.

The concentration of serum sodium was not altered with two weeks of bedrest. Using 27 Apollo crewmen for statistical analysis, a postflight decrease of 0.9% was observed. Three of the bedrest subjects showed postflight increase, one a decrease and one no change from preflight mean. Serum potassium was slightly decreased in 4 of the 6 subjects. The magnitude of the potassium was about the same as observed in the returning Apollo crewmen. Urinary potassium was elevated in bedrest and total body exchangeable potassium was decreased in most of the subjects, again these results compare favorably in direction if not in magnitude to the Apollo

results. The rigid adherence to the control diet (Table 1) during all phases of the study adds to the significance of the loss in both sodium and potassium.

The negative sodium and potassium balances have been accompanied by increased aldosterone excretion in space flight crewmen. An overall 37% increase was observed during this bedrest study which believed to be the only time that aldosterone has been shown to be elevated in bedrest in subjects on controlled diet and no medication. The magnitude of this increase, however, is not as great as that (84%) shown during the first two weeks of the Skylab flights. This finding of a slight increase in 6 subjects is unexpected and will allow us to examine new areas of commonality between bedrest and space flight.

Plasma aldosterone and renin activity were variable as with space flight but were generally decreased early then increased.

Blood urea nitrogen has been decreased following space flight. It was very slightly increased in 5 of the 6 bedrest subjects. Urinary creatinine was not altered during or post-bedrest and plasma creatinine was not effected by the two weeks of bedrest. These results are comparable to other bedrest findings.

Uric acid excretion was increased in 4 of the 6 subjects during this bedrest. This is unlike space flight where the excretion of uric acid was decreased. Plasma levels were not significantly changed with bedrest. Following space flight serum uric acid has generally been found to be decreased.

Bedrest has been used as an analog of space flight for the last fifteen years. With the more involved Skylab flight, the calcium metabolism has been shown to be very similarily effected by bedrest and space flight. Urinary calcium and phosphorous were elevated throughout the bedrest

as they were during the first two weeks of the Skylab flights. Serum calcium showed little effect; however, it is of interest that serum phosphorous was elevated in all of the 6 subjects after bedrest.

Adrenal hormones from the medulla and cortex have been of significant concern since early space flight. The findings during and following bedrest have been variable. This study showed overall increases in urinary cortisol with slight decreases during bedrest in plasma cortisol. Post bedrest plasma cortisol was slightly increased.

Epinephrine and norepinephrine was decreased during bedrest in all of the subjects. This is similar to the Skylab flights. The decrease in norepinephrine has been reported during bedrest. The very significant decrease in all crewmen is probably related to the complete absence of exercise during the bedrest phase.

To examine the reported decreases of plasma glucose with bedrest, insulin, growth hormone and glucose were measured before and following bedrest. Glucose was decreased in 3 of the subjects after 14 days of bedrest and insulin was slightly elevated in 5 of the 6. Human growth hormone was more variable but generallly post-bedrest values were higher than pre-values.

Cholesterol were also variable (3 higher and 3 lower than pre-values). This study did not show the decreased cholesterol which has been observed following space flight for as long as 3 weeks. However, 5 of the subjects did show slight increases in throxine. Apollo and Skylab results have also found increased thyroxine after space flight.

Alkaline phosphatase was increased in all 6 subjects after 2 weeks of bedrest. This enzyme has shown variable results after bedrest and has not been changed due to space flight. The role of alkaline phosphate

as they were during the first two weeks of the Skylab flights. in calcium metabolism would support the elevation of this enzyme in light of the increased calcium and phosphorous excretion. Following Apollo flights alkaline phosphatase was slightly increased; however it was slightly though not significantly decreased following Skylab.

Creatinine phosphokinase (CPK) and lactic dehydrogenase (LDH) were decreased following this bedrest study. Apollo results showed decreases postflight in both of these enzymes. After Skylab, CPK was generally increased during the recovery phase. This finding was supported by results of 2 of the bedrest subjects. Both the CPK and LDH results are intepreted to be related to decreased muscle activity during bedrest and Apollo flights and an increase during the post phase.

Significant biochemical changes have occurred during and after two weeks of absolute bedrest. Most of these changes are similar in direction if not magnitude to those observed during flight on the Skylab crewmen and postflight on the Apollo astronauts.

TABLE 1

SODIUM AND POTASSIUM INTAKE
(mEq/Day)

Mean ± S.D.

SUBJECT	SODIUM			POTASSIUM		
	PRE	IN	POST	PRE	IN	POST
1	270±22	272±24	265±22	99±9	96±8	95±8
2	204±21	212±29	203±27	88±10	86±11	95±8
3	268±21	280±19	264±20	107±9	112±6	113±31
4	252±27	247±21	243±25	84±11	83±12	81±14
5	257±20	256±20	257±17	87±7	83±9	85±5
6	242±36	222±13	219±16	84±8	81±7	82±7

Subject 1

TABLE 2
SERUM BIOCHEMISTRY RESULTS

	GLU mg%	CHOL mg%	SGOT mU/ml	BUN mg%	URIC ACID mg%	ALK. PHOS. IU	Ca mg%	Mg mg%	PO_4 mg%	BILI T. mg%	CREAT mg%	CPK mU/ml	LDH mU/ml	OSMO mOsmo	Na mEq/l	K mEq/l	Cl mEq/l	TRIGLY mg%
F-30	98	164	11	14	5.9	21	9.0	1.8	3.0	0.5	1.0	88	181	285	137	4.4	102	68
-21	100	155	11	19	6.3	19	8.5	1.8	3.3	0.5	1.1	115	185	290	139	4.2	104	29
-7	99	173	10	18	6.3	22	8.9	1.7	3.2	0.3	1.0	71	116	286	139	4.7	100	18
-1	98	175	9	14	7.2	18	9.0	1.7	3.1	0.2	1.2	57	142	293	143	4.5	105	35
MEAN±SD	99±1	167±9	10±1	16±3	6.4±.6	20±2	8.9±.2	1.8±.1	3.2±.1	.4±.2	1.1±1	83±25	156±33	289±4	140±3	4.5±.2	103±2	38±22
R+0	86	194	20	19	6.5	27	9.1	1.6	3.4	0.4	1.2	48	138	291	143	4.3	100	32
+1	99	180	17	19	6.8	28	9.2	1.6	3.9	0.2	1.2	150	116	292	143	4.5	100	56
+3	97	172	20	19	6.4	25	8.6	1.6	4.1	0.3	1.1	129	172	288	141	4.2	103	48
+14	100	167	12	15	6.8	22	8.8	1.5	3.8	0.2	1.0	74	159	290	142	4.4	102	56

Subject 2

TABLE 2

SERUM BIOCHEMISTRY RESULTS CONTINUED

	GLU mg%	CHOL mg%	SGOT mU/ml	BUN mg%	URIC ACID mg%	ALK. PHOS. IU	Ca mg%	Mg mg%	PO_4 mg%	BILI T. mg%	CREAT mg%	CPK mU/ml	LDH mU/ml	OSMO mOsmo	Na mEq/l	K mEq/l	Cl mEq/l	TRIGLY mg%
F-30	94	179	12	15	6.1	14	9.3	2.0	3.3	1.1	1.1	44	108	284	138	4.0	100	88
-21	92	150	12	11	5.5	14	8.7	1.9	2.8	0.8	1.0	62	86	281	139	3.8	99	67
-7	98	160	15	13	6.1	16	8.9	2.0	3.2	0.4	1.1	154	82	280	139	4.3	99	47
-1	93	156	13	15	6.1	12	9.1	1.8	3.3	0.4	1.1	106	77	296	144	4.2	103	58
MEAN±SD	94±3	161±13	13±1	14±2	6.0±.3	14±2	9.0±.3	1.9±.1	3.2±.2	.7±.3	1.1±.1	92±49	88±14	285±7	140±3	4.1±.2	100±2	65±17
R+0	85	140	12	13	5.4	19	8.7	1.9	3.5	0.6	1.1	43	82	286	142	3.9	99	74
+1	97	140	12	16	5.8	18	8.8	1.9	3.9	0.7	1.1	41	69	289	142	4.3	99	88
+3	90	135	12	14	5.5	15	8.4	2.0	3.7	0.6	1.1	44	86	285	142	3.9	100	91
+14	87	162	14	11	5.8	11	8.7	1.9	3.9	0.8	0.9	32	60	290	141	4.1	99	73

Subject 3

TABLE 2

SERUM BIOCHEMISTRY RESULTS CONTINUED

	GLU mg%	CHOL mg%	SGOT mU/ml	BUN mg%	URIC ACID mg%	ALK. PHOS. IU	Ca mg%	Mg mg%	PO_4 mg%	BILI T. mg%	CREAT mg%	CPK mU/ml	LDH mU/ml	OSMO mOsmo	Na mEq/l	K mEq/l	Cl mEq/l	TRIGLY mg%
F-20	94	254	15	11	7.4	18	9.3	1.9	3.7	0.3	1.0	35	176	286	138	4.3	101	92
-14	88	208	12	16	7.7	13	8.9	1.6	3.5	0.3	1.1	44	150	285	135	3.8	102	153
-7	99	211	12	19	7.8	18	9.0	1.8	3.8	0.2	1.2	46	155	283	138	4.5	102	119
-1	96	210	21	17	9.3	19	9.4	1.8	4.1	0.1	1.2	141	151	294	143	4.2	105	93
MEAN±SD	94±5	221±22	15±4	16±3	8.1±.9	17±3	9.2±.2	1.8±.1	3.8±.3	.2±.1	1.1±.1	67±50	158±12	287±5	139±3	4.2±.3	103±2	114±29
R+0	89	214	24	17	8.2	26	9.2	1.9	4.2	0.3	1.2	35	129	290	142	4.0	101	161
+1	100	217	23	22	8.2	29	8.9	1.8	5.0	0.2	1.3	48	108	297	142	4.8	102	332
+3	104	211	23	21	8.1	27	9.0	1.9	4.9	0.3	1.3	53	155	288	141	4.2	100	174
+14	91	210	12	22	8.0	19	9.3	1.9	4.7	0.2	1.0	53	129	290	140	4.3	103	219

Subject 4

TABLE 2

SERUM BIOCHEMISTRY RESULTS CONTINUED

	GLU mg%	CHOL mg%	SGOT mU/ml	BUN mg%	URIC ACID mg%	ALK. PHOS. IU	Ca mg%	Mg mg%	PO_4 mg%	BILI T. mg%	CREAT mg%	CPK mU/ml	LDH mU/ml	OSMO mOsmo	Na mEq/l	K mEq/l	Cl mEq/l	TRIGLY mg%
F-20.	88	177	17	9	5.0	13	9.9	2.1	3.3	0.9	1.1	90	138	282	139	4.3	101	82
-14	86	145	11	13	5.1	9	9.2	2.0	3.2	0.5	1.1	35	108	279	134	3.7	103	56
-7	86	149	13	14	5.2	11	9.4	2.0	3.8	0.3	1.1	65	65	279	133	4.3	101	50
-1	76	151	12	11	5.0	10	9.8	2.1	[illegible].7	0.2	1.2	46	73	295	143	4.1	103	107
MEAN±SD	84±5	156±15	13±3	12±2	5.1±.1	11±2	9.5±.3	2.1±.1	3.8±.7	.5±.3	1.1±.1	59±24	9[illegible]±34	28[illegible]±8	139±4	4.1±.3	102±1	74±26
R+0	89	161	13	16	4.7	13	9.6	1.9	4.7	0.4	1.2	21	60	291	132	4.2	104	74
+1	90	151	10	19	5.4	11	9.4	2.1	4.8	0.3	1.2	106	1[illegible]	304	142	4.3	102	95
+3	80	146	9	13	4.3	9	9.2	1.9	3.6	0.6	1.1	53	65	287	139	4.1	104	46
+14	87	154	10	11	5.7	9	9.0	2.0	4.7	0.4	1.4	42	90	282	141	3.7	104	71

Subject 5

TABLE 2

SERUM BIOCHEMISTRY RESULTS CONTINUED

	GLU mg%	CHOL mg%	SGOT mU/ml	BUN mg%	URIC ACID mg%	ALK. PHOS. IU	Ca mg%	Mg mg%	PO_4 mg%	BILI T. mg%	CREAT mg%	CPK mU/ml	LDH mU/ml	OSMO mOsmo	Na mEq/l	K mEq/l	Cl mEq/l	TRIGLY mg%
F-21	100	246	13	19	7.8	7	9.5	2.0	3.6	0.5	1.2	62	249	[illegible]	139	4.4	101	102
-14	92	219	14	14	6.5	7	9.0	2.0	2.8	0.3	1.0	51	193	283	133	4.4	102	206
-7	93	228	12	18	6.7	10	9.0	2.1	3.4	0.3	1.1	55	151	282	136	4.1	99	132
-1	94	204	13	17	6.8	8	9.2	2.1	4.2	0.1	1.2	99	180	292	142	4.2	103	268
MEAN±SD	95±4	224±18	13±1	17±2	7.0±.6	8±1	9.2±.2	2.1±.1	3.5±.6	.3±.2	1.1±.1	67±22	193±41	288±7	138±4	4.3±.2	101±2	177±75
R+0	98	214	10	19	6.6	11	8.9	2.0	4.5	0.4	1.1	34	129	288	139	4.2	99	154
+1	100	197	10	18	7.1	8	8.9	2.0	4.5	0.2	1.2	80	159	QNS	141	4.5	106	159
+3	86	191	9	18	7.1	8	8.8	2.0	4.5	0.2	1.1	39	146	287	139	4.2	103	105
+14	98	200	8	19	7.2	7	8.6	2.2	4.0	0.2	1.0	42	138	291	140	4.1	106	136

Subject 6

TABLE 2

SERUM BIOCHEMISTRY RESULTS CONTINUED

	GLU mg%	CHOL mg%	SGOT mU/ml	BUN mg%	URIC ACID mg%	ALK. PHOS. IU	Ca mg%	Mg mg%	PO_4 mg%	BILI T. mg%	CREAT mg%	CPK mU/ml	LDH mU/ml	OSMO mOsmo	Na mEq/l	K mEq/l	Cl mEq/l	TRIGLY mg%
F-20	102	208	12	18	5.8	42	9.6	2.1	3.4	0.4	1.0	60	168	294	140	4.4	101	98
-14	102	202	9	17	4.7	37	9.1	1.7	3.1	0.4	1.0	46	144	282	133	3.8	103	62
-7	107	211	13	15	4.8	39	9.3	2.0	3.6	0.2	1.0	51	120	285	138	4.1	101	51
-1	94	196	11	10	5.4	31	9.3	2.0	3.1	0.3	1.1	57	129	295	144	4.0	104	69
MEAN±SD	101±5	204±7	11±2	15±4	5.2±.5	37±5	9.3±.2	2.0±.2	3.3±.2	.3±.1	1.0±.1	54±6	140±21	289±6	139±5	4.1±.3	102±2	70±20
R+0	102	234	17	17	5.8	45	9.4	2.0	4.0	0.3	1.1	32	125	290	139	4.2	101	113
+1	98	217	18	16	5.9	36	9.0	2.0	3.5	0.3	1.0	53	129	304	140	4.1	104	88
+3	94	214	17	14	5.9	34	8.7	1.9	3.7	0.3	1.0	53	138	286	140	4.0	105	92
+14	96	217	13	15	5.5	38	9.0	2.1	3.5	0.5	1.0	41	129	288	140	4.2	103	57

Subject 1

TABLE 3
PLASMA HORMONE RESULTS

	ANGIO I mug/ml/Hour	INSULIN uUg/ml	CORTISOL ug/100ml	HGH mg/ml	ALDO pg/ml	ACTH pg/ml	T_3 % Uptake	T_4 ug/100ml
F-30	0.35	11	14.2	2.6	415	32.0		
F-21	0.45	10	15.5	1.9	259	20.5	35.4	9.1
F-7	0.57	10	19.0	1.9	242	32.0	33.5	9.1
F-1	0.56	8	10.7	1.9	290	17.8	34.2	6.2
MEAN $\pm$SD	.48$\pm$.10	10$\pm$2	14.9$\pm$3.4	2.1$\pm$.4	302$\pm$78	25.6$\pm$7.5	34.4$\pm$1.0	8.1$\pm$1.7
BR+2	0.42	-	13.7	-	129		-	-
BR+7	1.35	-	12.0	-	192		-	-
BR+14	0.96	-	14.0	-	163		-	-
R+0	1.07	15	19.0	2.4	238		33.1	8.9
R+1	0.94	12	14.1	3.5	256		33.5	7.9
R+3	0.48	9	15.0	12.4	197		34.6	7.5
R+13	0.76	10	10.3	1.9	155		32.3	7.0

Subject 2

TABLE [illegible]

PLASMA HORMONE RESULTS CONTINUED

	ANGIO I mug/ml/Hour	INSULIN uUg/ml	CORTISOL ug/100ml	HGH mg/ml	ALDO pg/ml	ACTH pg/ml	T_3 % Uptake	T_4 ug/100ml
F-30	0.81	9	12.5	2.2	467	10.8		
F-21	0.21	10	13.0	2.2	191	9.8	32.3	12.7
F-7	0.54	9	13.5	3.1	150	16.1	34.2	13.1
F-1	0.49	7	10.8	1.9	182	14.4	33.8	10.9
MEAN$\pm$SD	0.51$\pm$0.25	9$\pm$1	12.5$\pm$1.2	2.4$\pm$.5	248$\pm$147	12.8$\pm$3.0	33.4$\pm$1.0	12.2$\pm$1.2
BR+2	0.29	-	10.7	-	154		-	-
BR+7	0.70	-	10.7	-	140		-	-
BR+14	0.93	-	8.5	-	148		-	-
R+0	0.57	11	11.3	1.5	161		35.4	9.8
R+1	1.07	11	10.6	2.4	222		31.2	12.3
R+3	0.37	9	9.2	2.8	162		33.8	10.1
R+13	0.26	9	8.0	1.9	168		32.3	9.8

Subject 3

TABLE 3

PLASMA HORMONE RESULTS CONTINUED

	ANGIO I mug/ml/Hour	INSULIN uUg/ml	CORTISOL ug/100ml	HGH mg/ml	ALDO pg/ml	ACTH pg/ml	T_3 % Uptake	T_4 ug/100ml
F-30	0.45	9	18.5	3.1	420	16.1		
F-21	0.31	8	17.0	2.6	270	25.4	35.8	7.7
F-7	0.81	9	13.7	2.2	225	17.5	36.5	8.4
F-1	1.28	7	8.8	2.6	215	20.0	35.0	6.8
MEAN$\pm$SD	.71$\pm$.43	8$\pm$1	14.5$\pm$4.3	2.6$\pm$.4	283$\pm$95	19.8$\pm$4.1	35.8$\pm$.8	7.6$\pm$.8
BR+2	0.42	-	13.0	-	149		-	-
BR+7	0.63	-	16.0	-	179		-	-
BR+14	0.84	-	13.7	-	138		-	-
R+0	0.85	15	19.5	2.4	164		31.9	11.8
R+1	1.46	14	16.7	3.5	220		31.9	9.9
R+3	1.00	7	8.2	3.5	192		28.5	8.9
R+13	0.39	9	13.5	2.4	165		32.7	7.9

Subject 4

TABLE 3

PLASMA HORMONE RESULTS CONTINUED

	ANGIO I mug/ml/Hour	INSULIN uUg/ml	CORTISOL ug/100ml	HGH mg/ml	ALDO pg/ml	ACTH pg/ml	T_3 % Uptake	T_4 ug/100ml
F-30	0.30	10	14.2	2.2	399	14.1		
F-21	0.29	9	11.0	2.2	578	11.1	35.8	6.8
F-7	0.70	7	16.7	1.9	150	18.6	33.8	7.9
F-1	0.33	10	14.0	2.2	212	18.9	33.8	8.2
MEAN±SD	.41±.20	9±1	14.0±2.3	2.1±.2	335±194	15.7±3.8	34.5±1.2	7.6±.7
BR+2	0.84	-	8.1	-	233		-	-
BR+7	0.86	-	7.4	-	227		-	-
BR+14	0.60	-	12.0	-	227		-	-
R+0	0.68	10	10.0	3.5	239		33.8	8.9
R+1	0.95	9	12.8	3.9	234		35.8	10.4
R+3	0.73	7	7.4	2.4	147		36.2	8.5
R+13	0.87	9	15.0	2.4	177		34.2	7.6

Subject 5

TABLE 3
PLASMA HORMONE RESULTS CONTINUED

	ANGIO I mug/ml/Hour	INSULIN uUg/ml	CORTISOL ug/100ml	HGH mg/ml	ALDO pg/ml	ACTH pg/ml	T_3 % Uptake	T_4 ug/100ml
F-30	0.57	12	14.2	1.9	298	18.3		
F-31	0.03	9	12.0	1.9	410	18.0	35.8	8.7
F-7	0.20	6	12.3	2.2	114	20.5	30.8	9.4
F-1	0.03	10	6.6	2.6	131	14.4	33.8	8.6
MEAN±SD	.21±.25	9±3	11.3±3.3	2.2±.3	238±141	17.8±2.5	33.5±2.5	8.9±.4
BR+2	0.16	-	7.0	-	137		-	-
BR+7	0.67	-	8.8	-	176		-	-
BR+14	0.44	-	9.0	-	147		-	-
R+0	0.77	10	6.2	2.8	116		35.0	9.9
R+1	0.43	10	8.6	2.8	104		34.6	9.8
R+3	0.19	10	9.8	1.9	130		32.3	7.5
R+13	0.11	8	14.0	2.4	134		35.8	8.9

Subject 6

TABLE 3

PLASMA HORMONE RESULTS CONTINUED

	ANGIO I mug/ml/Hour	INSULIN uUg/ml	CORTISOL ug/100ml	HGH mg/ml	ALDO pg/ml	ACTH pg/ml	T_3 % Uptake	T_4 ug/100ml
F-30	1.04	10	11.0	1.9	329	18.0		
F-21	0.35	9	10.3	1.9	615	16.9	35.0	8.8
F-7	0.23	8	13.2	2.6	165	15.2	31.9	8.8
F-1	0.34	11	7.4	2.6	205	23.3	30.8	6.9
MEAN$\pm$SD	.49$\pm$.37	10$\pm$1	10.5$\pm$2.4	2.3$\pm$.4	329$\pm$203	18.4$\pm$3.5	32.6$\pm$2.2	8.2$\pm$1.1
BR+2	0.19	-	12.5	-	182		-	-
BR+7	0.31	-	8.1	-	174		-	-
BR+14	0.22	-	6.2	-	157		-	-
R+0	0.33	10	11.0	1.9	226		29.2	9.2
R+1	0.48	11	5.6	2.8	213		34.6	9.0
R+3	0.33	9	8.0	1.5	170		33.5	7.0
R+13	0.27	9	10.0	2.8	139		33.8	7.0

TABLE 4

24 HOUR URINE RESULTS

Subject 1

	VOLUME	SP GR GM/L	OSMOL MOSM	NA MEQ/24 HR	K MEQ/24 HR	CL MEQ/24 HR	CA MEQ/24 HR	MG MEQ/24 HR	IPO_4 MG/24 HR	URIC ACID MG/24 HR	CREATININE MG/24 HR	HOPRO MG/24 HR	H+
F-21	2215	1.010	434	216	60	175	6.1	12.6	1108	841	1905		34
-20	1655	1.017	760	[illegible]	83	281	9.9	13.6	1192	950	1920		18
-19	[illegible]	1.025	966	149	53	118	5.3	10.8	960	720	1888		141
-18	915	1.025	1071	214	81	157	6.7	11.8	1226	805	1702		143
-17	2180	1.013	589	339	79	294	6.6	13.5	1046	959	1744		0
-16	1280	1.014	551	140	45	153	10.7	7.9	819	742	2125		113
-15	1770	1.008	639	250	73	220	6.2	10.9	885	850	1947		40
-14	1760	1.014	679	241	97	236	6.0	9.5	1056	845	1936		11
-13	1800	1.014	597	210	67	184	21.3	13.0	1188	972	2268		115
-12	1720	1.012	545	236	57	229	5.5	12.5	722	826	1410		35
-11	1380	1.014	628	204	51	182	7.6	12.5	718	800	1518		63
-10	1120	1.019	801	165	65	143	5.7	11.0	1098	739	1994		159
-9	1510	1.016	710	238	91	217	8.2	10.6	1087	815	1721		12
-8	1535	1.018	808	287	89	255	8.1	15.1	1269	952	2118		63
-7	1260	1.016	673	170	68	158	5.9	8.9	857	731	1789		82
-6	1775	1.015	656	257	82	261	7.6	10.2	994	959	2034		71
-5	1540	1.015	656	234	69	202	5.9	9.5	924	801	1879		24
-4	1080	1.020	871	215	73	192	4.7	7.5	1037	734	1836		11
-3	1780	1.013	571	233	59	210	7.7	10.3	961	748	1709		50
-2	1220	1.017	735	167	65	143	5.4	8.2	976	708	1854		108
-1	855	1.018	700	115	41	93	4.5	6.9	752	632	1522		93
MEAN±SD	1483±400	1.016±0.004	694±148	220±59	70±15	196±53	7.4±3.6	10.8±2.2	993±164	816±98	1849±211		66±49

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TABLE 4

24 HOUR URINE RESULTS CONTINUED

Subject 1

	VOLUME	SP GR GM/L	OSMOL MOSM	NA MEQ/24 HR	K MEQ/24 HR	CL MEQ/24 HR	CA MEQ/24 HR	MG MEQ/24 HR	IPO_4 MG/24 HR	URIC ACID MG/24 HR	CREATININE MG/24 HR	HOPRO MG/24 HR	H+
BR1	2180	1.013	606	346	76	294	10.4	13.4	1134	1046	2093		16
2	3230	1.008	331	392	81	338	12.4	12.7	969	904	2003		0
3	1400	1.011	539	191	52	169	5.7	8.3	672	532	1176		17
4	1450	1.019	816	247	99	213	7.9	14.4	1102	870	2146		19
5	930	1.024	1043	196	66	184	6.4	9.8	1079	707	1730		149
6	1100	1.019	852	184	72	178	8.1	7.4	836	704	1518		86
7	1530	1.017	744	229	98	183	12.4	8.6	1201	916	2180		54
8	1560	1.011	689	259	64	211	9.0	13.0	874	842	1622		16
9	2345	1.011	567	287	101	253	10.1	13.0	1313	908	2345		65
10	1400	1.016	688	210	59	175	10.5	9.3	952	756	1624		46
11	1390	1.022	922	255	95	237	9.4	14.3	1352	958	2070		118
12	1930	1.015	637	244	87	237	9.1	13.7	1235	926	2277		94
13	1505	1.017	758	241	84	212	9.1	12.6	1294	963	1805		93
14	1520	1.020	770	258	88	234	8.3	9.8	1216	942	1842		28
MEAN±SD	1679±584	1.022±.020	712±177	253±58	80±16	225±54	9.2±1.9	11.5±2.4	1088±202	856±136	1888±330		57±45

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TABLE 4

24 HOUR URINE RESULTS CONTINUED

Subject 1

	VOLUME	SP GR GM/L	OSMOL MOSM	NA MEQ/24 HR	K MEQ/24 HR	CL MEQ/24 HR	CA MEQ/24 HR	MG MEQ/24 HR	IPO4 MG/24 HR	URIC ACID MG/24 HR	CREATININE MG/24 HR	HOPRO MG/24 HR	H+
R+0	1250	1.020	741	130	68	145	9.6	10.3	950	800	1800		118
1	1230	1.020	793	175	90	159	8.1	8.6	1033	935	1894		44
2	925	1.027	1007	172	67	162	5.8	11.5	1240	925	1776		155
3	1660	1.019	696	262	63	239	10.2	12.9	1328	1029	2058		101
4	1360	1.014	373	199	63	192	9.5	9.8	1004	1115	2083		195
5	2920	1.011	253	298	58	254	9.4	13.3	1225	1226	1986		24
6	1775	1.014	492	224	56	194	8.8	11.2	754	861	1903		58
7	2370	1.014	360	238	62	234	6.0	10.5	994	869	2029		56
8	1880	1.013	500	232	77	222	5.8	10.9	865	790	1842		44
9	2410	1.014	356	354	89	325	8.6	13.8	1253	1109	2458		20
10	1980	1.014	473	189	61	172	6.4	11.1	1168	950	2099		122
11	[illegible]	1.018	641	168	47	139	5.7	12.3	932	526	1316		181
12	1315	1.016	675	223	61	187	6.1	11.0	993	842	1894		95
13	1440	1.017	652	211	85	140	4.5	7.7	979	778	1786		73
MEAN±SD	1709±539	1.017±.004	572±207	221±59	71±14	197±53	7.5±1.9	11.1±1.7	1053±167	911±175	1959±183		92±56

TABLE 4

24 HOUR URINE RESULTS CONTINUED

Subject 2

	VOLUME	SP GR GM/L	OSMOL MOSM	NA MEQ/24 HR	K MEQ/24 HR	CL MEQ/24 HR	CA MEQ/24 HR	MG MEQ/24 HR	IPO$_4$ MG/24 HR	URIC ACID MG/24 HR	CREATININE MG/24 HR	HOPRO MG/24 HR	H+
F-21	2760	1.004	394	255	80	215	10.6	11.1	1104	1325	2318		0
-20	1710	1.014	525	180	72	154	8.2	8.2	1060	1094	2018		45
-19	1400	1.013	510	99	60	91	9.2	7.4	1036	1008	1904		105
-18	1395	1.015	522	171	73	124	12.2	9.9	1144	1200	2009		37
-17	2610	1.010	468	266	84	253	12.6	10.6	1096	1201	2036		5
-16	1520	1.016	530	159	65	161	8.1	7.5	790	882	1733		64
-15	1670	1.012	488	150	52	132	10.4	7.9	868	1035	2037		75
-14	1580	1.016	715	261	77	224	11.4	7.4	1074	1138	2212		0
-13	860	1.024	837	51	40	53	10.0	13.6	946	1221	2236		277
-12	1380	1.016	637	168	45	133	8.5	7.4	1021	1242	1877		80
-11	3030	1.009	401	332	73	294	13.6	10.3	848	1394	1939		0
-10	930	1.016	640	74	47	83	6.3	7.5	818	800	1748		190
-9	1600	1.012	526	168	69	157	8.9	5.9	896	1056	1760		71
-8	1400	1.017	676	190	63	162	11.5	7.3	1232	1120	2044		126
-7	1200	1.016	650	156	56	129	9.9	6.5	870	1178	1638		60
-6	2530	1.010	368	221	78	197	11.8	7.1	1113	1316	2125		49
-5	1700	1.014	582	209	53	180	9.9	9.6	1122	1258	1972		65
-4	1200	1.019	672	138	76	125	8.0	8.1	1104	1008	1920		147
-3	1300	1.013	517	201	86	169	10.9	9.5	1234	1353	2149		51
-2	680	1.025	915	77	44	65	6.4	5.8	925	911	1863		268
-1	810	1.025	966	125	52	116	8.3	7.8	1037	1102	1863		191
MEAN±SD	1621±646	1.015±0.005	597±162	174±70	65±14	155±60	9.8±2.0	8.4±1.9	1016±132	1135±159	1971±177		92±82

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TABLE 4

24 HOUR URINE RESULTS CONTINUED

Subject 2

	VOLUME	SP GR GM/L	OSMOL MOSM	NA MEQ/24 HR	K MEQ/24 HR	CL MEQ/24 HR	CA MEQ/24 HR	MG MEQ/24 HR	IPO_4 MG/24 HR	URIC ACID MG/24 HR	CREATININE MG/24 HR	HOPRO MG/24 HR	H+
BR1	2000	1.011	606	319	62	244	13.3	7.2	1040	1400	2160		8
2	2615	1.009	395	260	58	230	13.4	8.6	994	993	1726		18
3	1620	1.015	468	168	71	159	10.2	9.4	1069	1004	1879		102
4	1970	1.011	382	161	83	158	10.8	6.9	906	1024	1891		55
5	1515	1.017	698	195	74	167	11.5	8.1	1212	1182	2060		47
6	2050	1.010	443	180	82	152	11.6	10.3	984	1025	2050		36
7	1760	1.010	562	188	79	169	9.5	6.7	1021	1091	1971		24
8	1670	1.014	584	191	67	174	11.9	9.6	1035	969	1837		58
9	2655	1.009	417	236	74	228	14.7	9.7	1062	1115	2071		37
10	1670	1.011	467	144	43	127	7.5	4.4	835	935	1703		76
11	1560	1.014	606	176	72	156	9.7	9.6	1154	998	1966		94
12	1800	1.012	509	183	66	162	8.7	7.9	1090	1128	2068		61
13	2325	1.005	458	226	77	193	13.4	9.1	1070	1163	2186		44
14	2580	1.013	431	239	77	206	14.2	10.6	1238	1496	2270		36
MEAN±SD	1991±403	1.012±0.003	502±95	204±48	71±10	180±35	11.4±2.2	8.4±1.7	1050±108	1109±163	1988±168		50±27

TABLE 4

24 HOUR URINE RESULTS CONTINUED

Subject 2

	VOLUME	SP GR GM/L	OSMOL MOSM	NA MEQ/24 HR	K MEQ/24 HR	CL MEQ/24 HR	CA MEQ/24 HR	MG MEQ/24 HR	IPO_4 MG/24 HR	URIC ACID MG/24 HR	CREATININE MG/24 HR	HOPRO MG/24 HR	H+
R+0	810	1.023	757	78	54	83	8.8	6.6	859	1279	1571		270
1	1030	1.024	829	122	63	102	10.4	10.0	1195	1751	2060		232
2	1010	1.025	835	172	56	145	8.9	8.1	1151	1273	1919		211
3	1360	1.018	423	166	46	141	10.6	10.0	1142	1441	2203		187
4	1350	1.023	805	177	68	170	9.2	11.8	1008	2394	2058		110
5	1840	1.015	399	197	55	167	11.3	11.2	1177	1214	2024		103
6	2375	1.012	383	286	64	264	10.9	7.9	808	1092	2138		27
7	1520	1.015	492	126	61	120	7.7	8.0	1071	1132	2050		144
8	1240	1.022	732	174	83	162	8.6	8.8	1240	1290	2083		194
9	1185	1.021	712	133	58	124	8.2	9.9	1303	1422	2109		225
10	1590	1.016	566	186	70	184	10.9	9.8	1018	1272	2099		100
11	1220	1.019	681	165	57	150	9.2	9.7	952	1074	1976		134
12	2175	1.013	293	215	54	196	8.8	8.4	1175	1088	2028		77
13	1570	1.014	480	173	86	176	12.7	8.5	1085	1122	2057		82
MEAN±SD	1448±468	1.019±.004	606±195	169±49	63±11	156±45	9.7±1.4	9.2±1.4	1085±142	1346±352	2031±149		150±71

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TABLE 4

24 HOUR URINE RESULTS CONTINUED

Subject 3

	VOLUME	SP GR GM/L	OSMOL MOSM	NA MEQ/24 HR	K MEQ/24 HR	U-CL MEQ/24 HR	CA MEQ/24 HR	MG MEQ/24 HR	IPO4 MG/24 HR	URIC ACID MG/24 HR	CREATININE MG/24 HR	HOPRO MG/24 HR	H+
F-21	1810	1.013	499	192	58	154	8.8	12.7	1158	833	1991		129
-20	1800	1.014	603	265	83	50	8.1	12.9	1260	964	1980		111
-19	2000	1.003	502	206	82	102	8.1	10.9	1240	920	2000		114
-18	1620	1.015	660	234	78	198	7.9	13.5	1231	1037	1879		122
-17	1715	1.014	611	217	62	185	8.2	14.3	995	1029	1955		129
-16	1800	1.011	491	202	72	193	12.0	9.2	756	792	1534		41
-15	2270	1.013	566	250	73	220	9.8	15.9	1271	1090	2452		132
-14	1720	1.014	595	234	77	206	8.3	10.4	963	826	1686		99
-13	2580	1.013	529	253	101	194	9.2	12.8	1651	1084	2528		137
-12	2115	1.012	495	190	72	167	6.2	11.4	1142	1058	1946		127
-11	2550	1.003	521	270	[illegible]	242	8.6	14.3	1034	1123	2058		67
-10	1490	1.014	554	149	64	127	5.8	10.3	894	775	1877		130
-9	1840	1.012	545	221	70	201	8.1	8.9	846	846	1509		87
-8	2340	1.014	572	254	98	234	13.2	[illegible]	1404	1170	2621		155
-7	1880	1.013	558	212	70	199	9.2	10.2	1052	902	1805		133
-6	2990	1.010	408	[illegible]	108	275	10.4	12.0	1076	1076	2153		74
-5	1990	1.012	504	191	78	159	7.1	11.2	915	875	1990		142
-4	2400	1.012	522	276	84	238	10.4	13.6	1056	960	2208		94
-3	1460	1.016	636	170	59	149	6.0	9.7	993	701	1927		198
-2	1620	1.016	479	173	66	144	9.4	9.6	1555	875	2203		270
-1	1640	1.010	583	169	80	161	5.5	7.6	1181	951	2263		206
MEAN±SD	1973±392	1.012±0.003	547±58	220±39	79±14	181±51	8.6±1.9	11.7±2.2	1127±316	943±130	2030±285		128±50

TABLE 4

24 HOUR URINE RESULTS CONTINUED

Subject 3

	VOLUME	SP GR GM/L	OSMOL MOSM	NA MEQ/24 HR	K MEQ/24 HR	CL MEQ/24 HR	CA MEQ/24 HR	MG MEQ/24 HR	IPO_4 MG/24 HR	URIC ACID MG/24 HR	CREATININE MG/24 HR	HOPRO MG/24 HR	H+
BR1	2740	1.010	394	310	99	279	9.6	12.1	1260	1115	3288		107
2	3450	1.007	339	285	90	255	7.8	14.0	1035	966	2691		45
3	1740	1.014	600	250	84	218	6.5	13.7	940	766	1949		117
4	2270	1.014	585	250	102	243	8.3	15.8	1135	953	2270		91
5	2615	1.013	559	309	105	272	12.4	16.1	1412	1045	2615		125
6	2340	1.012	520	220	103	205	9.0	11.7	1310	1030	2340		150
7	2240	1.013	540	256	94	224	6.7	12.9	1165	1030	2150		98
8	3120	1.012	532	349	134	321	15.3	15.6	1810	1373	2995		126
9	2950	1.011	478	282	104	248	10.2	13.0	1267	1037	2419		102
10	3020	1.008	395	260	82	214	11.1	11.9	1027	905	1933		89
11	[illegible]	1.010	441	217	83	193	10.3	10.7	1054	1004	2108		103
12	2830	1.012	504	254	92	242	10.2	14.2	1368	1052	2524		155
13	2425	1.012	517	257	104	233	10.8	12.2	1154	1164	2134		105
14	3740	1.011	413	283	97	267	9.1	12.5	1319	1058	2072		105
MEAN±SD	2651±448	1.011±.0021	487±79	272±35	98±14	245±34	9.8±2.3	13.3±1.7	1233±218	1036±136	2392±398		108±27

TABLE 4

24 HOUR URINE RESULTS CONTINUED

Subject 3

	VOLUME	SP GR GM/L	OSMOL MOSM	NA MEQ/24 HR	K MEQ/24 HR	CL MEQ/24 HR	CA MEQ/24 HR	MG MEQ/24 HR	IPO_4 MG/24 HR	URIC ACID MG/24 HR	CREATININE MG/24 HR	HOPRO MG/24 HR	H+
R+0	2130	1.013	445	186	89	185	8.9	10.1	1090	1003	1962		111
1	1730	1.020	690	196	97	180	6.9	11.0	1314	1246	2214		171
2	2130	1.015	544	216	85	205	9.8	12.9	1352	1221	2223		151
3	1680	1.019	668	216	66	223	7.9	10.8	1411	1243	2251		201
4	2230	1.016	537	220	91	288	12.3	13.1	1293	1249	2185		156
5	2030	1.014	471	131	69	153	7.6	10.3	1137	1015	1989		170
6	2235	1.015	554	267	96	268	10.7	10.7	1118	1252	2220		117
7	1280	1.022	756	159	57	148	9.2	11.8	918	942	2083		246
8	2245	1.014	491	234	72	243	8.8	12.6	1257	1078	2245		161
9	2050	1.016	571	265	90	258	8.4	10.6	1312	1148	2419		145
10	1820	1.017	508	242	78	229	7.6	11.5	1165	1055	2002		162
11	1905	1.015	525	202	72	194	8.4	13.4	1105	953	1943		142
12	1090	1.024	837	177	77	155	7.4	12.0	1221	937	1984		298
13	1530	1.023	839	202	83	202	7.1	10.9	958	1109	2041		204
MEAN±SD	1851±396	1.017±.0036	609±130	210±34	80±12	205±38	8.6±1.5	11.6±1.1	1189±145	1104±123	2130±148		174±50

TABLE 4

24 HOUR URINE RESULTS CONTINUED

Subject 4

	VOLUME	SP GR GM/L	OSMOL MOSM	NA MEQ/24 HR	K MEQ/24 HR	CL MEQ/24 HR	CA MEQ/24 HR	MG MEQ/24 HR	IPO4 MG/24 HR	URIC ACID MG/24 HR	CREATININE MG/24 HR	HOPRO MG/24 HR	H+
F-21	925	1.025	1010	158	60	166	9.1	12.5	1277	907	2442		212
-20	875	1.022	1089	232	63	180	8.7	5.7	823	858	2100		0
-19	1105	1.019	823	221	46	197	10.3	8.7	561	774	1879		98
-18	1430	1.012	695	228	62	200	9.8	10.1	915	887	2059		13
-17	1715	1.015	679	298	65	271	11.3	7.1	1132	995	2367		22
-16	1260	1.017	684	162	62	159	7.0	8.6	1084	932	2065		160
-15	1415	1.017	765	264	71	224	7.7	7.8	877	934	2009		23
-14	2195	1.007	561	231	79	239	10.4	9.1	966	1054	2327		0
-13	1240	1.017	749	236	57	208	9.0	10.1	1166	843	1959		74
-12	1780	1.011	519	198	66	185	7.0	7.3	926	748	1922		30
-11	1055	1.021	834	197	76	175	5.9	6.8	992	801	1899		12
-10	1930	1.010	449	179	70	162	9.3	12.2	1140	1026	2356		81
-9	1235	1.017	531	139	63	133	7.1	7.9	1036	832	2290		187
-8	1620	1.015	646	233	62	178	9.3	10.7	972	1102	2203		26
-7	940	1.019	813	175	50	161	11.4	17.6	959	714	1842		162
-6	1160	1.026	1057	236	74	194	9.0	12.3	1485	1253	3016		255
-5	400	1.027	1104	96	29	86	4.6	3.6	296	480	1224		234
-4	1690	1.012	543	197	59	164	8.0	7.5	1032	913	2231		91
-3	970	1.021	910	222	58	176	7.6	8.5	834	873	2134		89
-2	1750	1.014	628	271	74	210	8.4	9.7	1085	1015	2415		74
-1	1720	1.014	622	292	77	225	8.8	7.0	929	791	2064		14
MEAN±SD	1350±429	1.017±0.005	751±198	215±52	63±12	185±39	8.6±1.7	9.1±3.0	992±224	895±159	2134±488		88±82

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TABLE 4

24 HOUR URINE RESULTS CONTINUED

Subject 4

	VOLUME	SP GR GM/L	OSMOL MOSM	NA MEQ/24 HR	K MEQ/24 HR	CL MEQ/24 HR	CA MEQ/24 HR	MG MEQ/24 HR	IPO4 MG/24 HR	URIC ACID MG/24 HR	CREATININE MG/24 HR	HOPRO MG/24 HR	H+
BR1	1490	1.018	609	274	70	200	6.5	8.1	1341	1013	2354		106
2	610	1.028	1191	148	57	146	5.5	6.9	708	683	1513		197
3	740	1.029	1192	159	64	142	6.6	7.7	858	459	1566		218
4	1020	1.025	1071	275	58	237	12.0	6.6	1122	959	2183		100
5	800	1.014	785	153	51	130	2.4	2.4	448	560	1056		0
6	1345	1.020	894	265	82	249	10.9	10.9	1076	915	2233		100
7	960	1.026	1098	248	58	203	9.6	4.1	1075	845	1939		85
8	650	1.029	1222	175	55	155	6.3	7.7	767	653	1469		154
9	760	1.028	1165	168	57	144	8.5	9.1	973	745	1626		229
10	1265	1.028	1161	287	106	267	13.0	14.1	1796	1265	2960		[illegible]
11	1195	1.022	813	215	63	202	9.1	9.8	1123	1004	2008		61
12	910	1.024	393	185	62	168	7.9	8.2	892	728	1620		76
13	870	1.029	1111	211	54	135	9.1	8.8	1096	940	1984		117
14	2210	1.016	573	287	84	267	11.5	12.1	1282	1149	2307		43
MEAN±SD	1059±425	1.024±.005	984±222	218±54	67±15	194±47	8.5±2.9	8.3±3.0	1040±320	852±226	1938±478		120±69

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TABLE 4

24 HOUR URINE RESULTS CONTINUED

Subject 4

	VOLUME	SP GR GM/L	OSMOL MOSM	NA MEQ/24 HR	K MEQ/24 HR	CL MEQ/24 HR	CA MEQ/24 HR	MG MEQ/24 HR	IPO_4 MG/24 HR	URIC ACID MG/24 HR	CREATININE MG/24 HR	HOPRO MG/24 HR	H+
R+0	670	1.032	1186	125	70	130	6.8	7.9	1045	1085	1970		326
1	780	1.031	1135	169	61	144	6.7	8.8	998	1154	1872		126
2	1500	1.021	783	264	75	225	10.5	10.0	1230	1200	2070		46
3	1905	1.016	370	290	80	200	9.2	9.8	1029	953	1867		15
4	2410	1.013	482	241	63	217	10.0	10.2	1205	1205	2314		103
5	1635	1.015	536	168	49	159	8.8	10.3	818	1112	1831		77
6	1050	1.024	564	139	43	128	8.5	11.5	1323	1239	2415		253
7	715	1.023	929	200	46	161	5.7	3.8	458	901	1344		0
8	1610	1.014	512	180	53	177	7.0	8.0	837	966	1996		93
9	1180	1.022	792	181	44	155	11.5	19.8	1345	1912	2242		242
10	1120	1.023	833	187	49	161	9.8	14.0	1075	1523	2106		238
11	1590	1.017	610	234	54	195	6.6	8.5	1113	1081	1940		88
12	990	1.021	784	158	56	155	5.5	7.3	752	950	2020		171
13	1370	1.019	700	221	73	184	8.6	7.4	986	1069	2028		25
MEAN±SD	1323±492	1.021±.006	730±240	197±48	59±12	177±41	8.2±1.9	9.8±3.7	1015±240	1168±266	2001±255		129±102

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TABLE 4

24 HOUR URINE RESULTS CONTINUED

Subject 5

	VOLUME	SP GR GM/L	OSMOL MOSM	NA MEQ/24 HR	K MEQ/24 HR	U-CL MEQ/24 HR	U-CA MEQ/24 HR	U-MG MEQ/24 HR	U-IPO4 MG/24 HR	U-URIC ACID MG/24 HR	U-CREATININE MG/24 HR	U-HOPRO MG/24 HR	H+
F-21	1270	1.019	832	250	85	234	9.3	10.8	1118	965	2184		85
-20	1045	1.023	928	173	88	155	8.5	10.9	1170	961	2341		221
-19	1020	1.021	883	182	54	137	10.3	10.5	1204	775	1836		167
-18	1375	1.019	955	272	84	249	10.2	9.5	1128	935	1980		100
-17	1365	1.020	872	246	74	212	11.4	14.7	1420	1010	2375		105
-16	1600	1.024	967	183	73	173	9.4	10.5	1320	920	2300		303
-15	1135	1.022	944	220	69	199	7.7	9.4	1112	863	1521		199
-14	900	1.023	958	158	58	129	9.6	10.4	1152	792	1980		292
-13	1030	1.023	990	191	75	152	10.9	10.4	1092	865	2225		245
-12	860	1.025	1038	153	52	125	10.8	10.3	1135	740	1961		308
-11	1130	1.022	965	301	72	225	10.6	8.4	1175	814	2079		139
-10	1120	1.021	911	230	55	205	13.1	12.8	1098	896	2218		235
-9	1040	1.022	952	230	67	180	9.4	3.2	1144	686	1914		226
-8	1150	1.022	925	265	76	231	10.3	9.8	1150	874	2070		187
-7	1180	1.021	944	238	84	220	10.2	9.8	1204	826	1959		189
-6	930	1.026	1037	145	79	140	11.7	12.9	1215	852	2254		392
-5	700	1.021	1047	92	53	90	7.4	6.1	812	686	1988		441
-4	675	1.028	1056	89	37	70	8.1	8.0	1026	783	1904		436
-3	1010	1.024	1003	225	70	193	9.7	9.1	1172	990	2262		265
-2	920	1.023	994	157	78	175	7.1	7.4	1104	893	1969		290
-1	1100	1.024	965	231	61	178	10.9	10.5	1364	924	2112		253
MEAN±SD	1046±180	1.023±.002	959±62	205±57	69±13	177±48	9.8±1.5	9.8±2.4	1158±122	860±93	2068±202		244±106

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TABLE 4

24 HOUR URINE RESULTS CONTINUED

Subject 5

	VOLUME	U-SP GR GM/L	U-OSMOL MOSM	U-NA MEQ/24 HR	U-K MEQ/24 HR	U-CL MEQ/24 HR	U-CA MEQ/24 HR	U-MG MEQ/24 HR	U-IPO_4 MG/24 HR	U-URIC ACID MG/24 HR	U-CREATININE MG/24 HR	U-HOPRO MG/24 HR	H+
BR1	1110	1.022	952	240	76	202	10.4	9.2	1199	844	2020		219
2	1075	1.017	771	220	48	163	9.3	6.9	774	645	1527		101
3	870	1.018	964	151	63	161	8.8	8.3	1044	731	2088		390
4	920	1.021	931	248	51	204	10.1	7.3	609	736	1417		37
5	1030	1.021	941	249	66	223	10.7	8.2	836	845	1627		108
6	1365	1.024	1019	272	96	250	17.4	7.6	1802	1092	2812		375
7	1620	1.019	815	238	91	217	16.0	11.7	1264	1037	2560		144
8	945	1.017	731	154	42	133	9.7	6.8	794	585	1247		155
9	1030	1.021	873	166	65	151	11.1	13.2	1030	803	1833		263
10	1700	1.021	856	347	126	316	16.3	17.0	1632	1224	2890		180
11	1190	1.024	912	254	74	219	12.4	11.9	1119	1333	1952		127
12	1160	1.025	921	211	81	196	12.1	11.5	1322	1160	2118		278
13	1300	1.020	743	206	66	170	10.0	9.6	998	988	1872		178
14	1190	1.023	591	232	75	218	11.4	10.6	952	1023	1928		174
MEAN±SD	1179±247	1.021±0.002	863±115	230±51	73±21	202±47	11.9±2.8	10.0±2.9	1108±317	932±225	1992±489		195±101

TABLE 4

24 HOUR URINE RESULTS CONTINUED

Subject 5

	VOLUME	U-SP GR GM/L	U-OSMOL MOSM	U-NA MEQ/24 HR	U-K MEQ/24 HR	U-CL MEQ/24 HR	U-CA MEQ/24 HR	U-MG MEQ/24 HR	U-TPO$_4$ MG/24 HR	U-URIC ACID MG/24 HR	U-CREATININE MG/24 HR	U-HOPRO MG/24 HR	H+
R+0	900	1.026	917	122	65	113	10.8	10.9	1152	1250	2052		384
1	950	1.026	962	193	76	206	10.0	10.7	912	1045	1900		185
2	1130	1.025	950	234	75	202	13.5	12.9	1107	1266	2170		179
3	845	1.023	945	203	63	199	7.1	6.4	676	777	1453		66
4	1350	1.024	931	290	88	253	12.2	15.6	1414	1360	2666		205
5	880	1.020	731	177	45	159	8.3	9.4	596	546	1338		76
6	960	1.028	1014	173	82	170	9.7	12.4	1440	1229	2688		468
7	1490	1.022	552	234	79	218	11.7	13.1	1460	1252	2712		196
8	690	1.030	1069	79	64	73	5.6	9.5	1132	1297	2070		534
9	715	1.029	642	84	53	54	6.6	11.7	1115	872	1859		360
10	1250	1.025	670	281	90	255	10.2	14.9	1150	1175	2250		90
11	910	1.026	936	209	61	198	8.2	9.6	1001	783	1911		257
12	760	1.029	1034	154	62	139	6.5	9.7	1140	973	2204		436
13	610	1.032	1125	86	62	56	5.4	9.6	952	915	1830		537
MEAN±SD	961±259	1.026±0.003	898±171	181±69	69±13	167±64	9.0±2.6	11.2±2.5	1089±256	1054±247	2079±419		249±161

TABLE 4

24 HOUR URINE RESULTS CONTINUED

Subject 6

	VOLUME	U-SP GR GM/L	U-OSMOL MOSM	U-NA MEQ/24 HR	U-K MEQ/24 HR	U-CL MEQ/24 HR	U-CA MEQ/24 HR	U-MG MEQ/24 HR	U-IPO$_4$ MG/24 HR	U-URIC ACID MG/24 HR	U-CREATININE MG/24 HR	U-HOPRO MG/24 HR	H+
BR1	1375	1.015	667	244	53	199	10.0	8.8	790	743	1650		87
2	1065	1.021	922	244	53	199	11.4	9.0	1129	895	1789		182
3	1480	1.018	720	185	74	185	19.8	13.4	1154	947	2250		218
4	840	1.021	854	165	50	149	8.6	6.9	756	655	1361		218
5	1730	1.015	657	250	95	234	14.1	12.1	1073	1073	2284		18
6	810	1.021	871	166	41	127	8.6	9.4	923	670	1458		191
7	1320	1.016	703	270	59	187	11.8	8.8	950	818	1795		97
8	1270	1.019	845	237	79	215	12.4	11.0	1092	991	1880		101
9	1170	1.018	733	129	62	140	11.2	10.5	796	772	1755		178
10	970	1.017	884	197	62	164	11.5	11.5	892	834	1659		127
11	1430	1.018	663	225	76	219	12.0	9.2	515	915	1973		0
12	1200	1.019	707	205	53	157	11.9	7.0	912	888	1656		0
13	1390	1.018	682	221	64	203	12.7	11.6	945	917	1668		94
14	1445	1.019	703	218	68	192	11.1	11.7	1156	1040	1762		105
MEAN±SD	1250±260	1.018±0.002	759±95	207±35	64±14	184±32	11.9±2.7	10.1±1.9	935±182	868±128	1782±257		115±75

TABLE 4

24 HOUR URINE RESULTS CONTINUED

Subject 6

	VOLUME	U-SP GR GM/L	U-OSMOL MOSM	U-NA MEQ/24 HR	U-K MEQ/24 HR	U-CL MEQ/24 HR	U-CA MEQ/24 HR	U-MG MEQ/24 HR	U-IPO4 MG/24 HR	U-URIC ACID MG/24 HR	U-CREATININE MG/24 HR	U-HOPRO MG/24 HR	H+
F-21	1450	1.023	954	237	80	270	12.0	14.5	1537	1160	2755		230
-20	1295	1.019	739	246	64	209	10.2	10.8	932	932	1839		17
-19	1280	1.012	609	226	53	157	8.4	7.8	666	666	1510		29
-18	1050	1.022	914	206	70	175	8.9	8.9	945	819	2016		33
-17	1160	1.020	857	205	57	216	10.1	8.8	812	766	1740		82
-16	1080	1.021	851	204	67	192	7.9	8.6	907	778	1879		93
-15	1425	1.020	871	[illegible]	84	248	9.3	12.2	1368	1055	2337		88
-14	1765	1.009	659	[illegible]	60	237	17.3	8.2	847	812	1765		21
-13	1110	1.016	660	150	49	124	7.7	7.8	834	733	1843		145
-12	1340	1.015	668	233	56	138	9.7	5.0	804	697	1528		0
-11	1035	1.022	983	214	78	188	9.0	7.9	1345	890	1863		100
-10	840	1.021	803	[illegible]	48	131	6.9	7.2	857	555	1411		228
-9	1120	1.019	796	215	73	169	6.4	7.8	1075	806	1725		31
-8	1610	1.014	631	241	93	216	8.7	8.5	1127	837	2061		87
-7	1220	1.015	689	207	57	162	5.9	7.6	952	683	1513		105
-6	1030	1.022	933	207	71	181	7.5	11.3	1030	865	1854		194
-5	830	1.024	992	[illegible]	58	106	9.0	10.6	1126	827	1725		419
-4	360	1.019	802	58	18	48	3.2	2.9	346	266	583		210
-3	830	1.023	963	198	52	160	7.0	7.2	1033	845	1707		80
-2	605	1.022	889	141	56	141	6.2	7.1	869	692	1707		299
-1	1340	1.017	712	235	55	198	8.5	10.1	938	884	1876		108
MEAN±SD	1146±308	1.019±0.004	812±126	209±52	63±16	180±48	8.6±2.7	8.6±2.5	969±254	794±173	1773±402		124±106

TABLE 4

24 HOUR URINE RESULTS CONTINUED

Subject 6

	VOLUME	U-SP GR GM/L	U-OSMOL MOSM	U-NA MEQ/24 HR	U-K MEQ/24 HR	U-CL MEQ/24 HR	U-CA MEQ/24 HR	U-MG MEQ/24 HR	U-IPO4 MG/24 HR	U-URIC ACID MG/24 HR	U-CREATININE MG/24 HR	U-HOPRO MG/24 HR	H+
R+0	1110	1.020	679	105	76	119	8.7	8.9	844	888	1665		223
1	720	1.027	746	123	70	112	15.0	7.8	893	792	1584		120
2	1260	1.019	678	227	58	176	7.7	8.2	958	983	1865		2
3	1545	1.017	620	246	65	212	8.5	9.4	1082	1051	1761		104
4	1370	1.019	594	241	77	207	7.0	7.9	986	959	1863		22
5	810	1.026	953	150	61	[illegible]	7.2	9.3	1134	1037	1652		375
6	860	1.028	1002	178	66	165	7.4	8.0	894	998	1617		311
7	1035	1.026	957	239	75	204	7.1	9.8	1146	1106	1869		109
8	735	1.027	922	120	44	122	6.0	11.2	926	1250	1852		442
9	1015	1.021	735	155	43	149	6.5	8.8	731	1096	1604		188
10	1390	1.020	729	248	70	222	6.8	9.1	1056	1140	2085		124
11	1130	1.025	956	230	76	228	7.7	9.3	1333	1107	1853		110
12	1150	1.022	525	182	60	178	8.1	9.9	1012	989	1817		262
13*	410	1.027	970	74	29	72	3.2	5.2	508	500	943		415
MEAN±SD	1085±261	1.021±0.006	784±154	193±57	65±11	171±42	8.0±2.2	9.0±1.0	1000±155	1030±117	1776±145		201±142

*Mission Day R+13 Not Included in Mean ± SD Calculation

TABLE 5

URINARY HORMONE RESULTS

Subject 1	VOLUME	CORTISOL ug/TV	EPI ug/TV	NOR ug/TV	ALDO ug/TV	ADH mU/TV
F-21	2215	94.1	40.6	45.7	6.2	48.2
-20	1655	95.2	11.5	41.6	5.8	105.6
-19	800	52.0	2.6	27.0	7.7	56.2
-18	915	59.0	6.2	35.9	5.7	42.7
-17	2180	112.3	7.7	39.6	3.5	43.5
-16	1280	68.5	12.8	47.0	7.7	57.8
-15	1770	97.4	7.2	36.2	11.3	56.6
-14	1760	82.7	8.9	36.2	12.8	33.9
-13	1800	63.9	21.6	66.6	12.6	31.2
-12	1720	28.4	15.7	22.0	6.2	23.0
-11	1380	69.0	15.7	29.7	7.5	27.6
-10	1120	104.7	15.8	37.0	3.6	27.8
-9	1510	14.7	LTD	37.4	17.0	24.2
-8	1535	42.2	17.1	41.4	10.8	33.7
-7	1260	48.5	11.6	44.0	12.1	62.2
-6	1775	54.1	38.5	36.6	6.6	89.7
-5	1540	39.3	24.1	34.3	9.9	31.9
-4	1080	45.9	11.0	24.5	13.4	43.2
-3	1780	51.6	42.6	30.5	13.1	29.8
-2	1220	36.6	23.9	40.1	18.3	23.5
-1	855	33.8	1.4	28.5	11.3	27.4
MEAN±SD	1483±400	61.6±27	16.0±12	37.2±10	9.7±4	48.5±23
BR1	2180	41.4	15.5	21.4	11.5	40.6
2	3230	77.5	20.3	22.0	11.4	37.8
3	1400	65.8	13.2	14.3	9.5	17.9
4	1450	77.6	21.7	31.5	25.0	67.9
5	930	79.0	11.1	21.6	12.9	24.8
6	1100	56.7	26.9	21.7	11.8	36.5
7	1580	77.4	8.3	21.3	16.4	56.7
8	1670	40.5	1.4	22.3	11.9	44.7
9	2345	84.0	7.1	31.5	20.2	45.2
10	1400	40.6	5.8	18.8	11.2	31.6
11	1380	92.5	8.2	46.2	15.4	26.7

TABLE 5

URINARY HORMONE RESULTS CONTINUED

Subject 1	VOLUME	CORTISOL ug/TV	EPI ug/TV	NOR ug/TV	ALDO ug/TV	ADH mU/TV
BR12	1930	111.0	5.1	30.2	22.5	43.9
13	1505	59.7	26.2	9.8	13.0	42.0
14	1520	91.2	15.0	27.6	12.4	29.3
R+0	1250	30.6	LTD	62.8	23.5	26.6
1	1230	48.0	19.9	40.8	18.2	23.8
2	925	62.9	15.2	36.2	9.8	34.7
3	1660	64.7	LTD	78.0	16.7	41.1
4	1860	59.5	25.2	45.0	11.1	32.2
5	2920	27.7	37.8	27.3	9.2	29.6
6	1795	29.6	LTD	42.5	9.4	57.6
7	2070	50.7	1.8	35.2	9.2	23.7
8	1880	150.4	2.8	45.8	11.3	20.0
9	2410	36.2	LTD	194.3	7.4	33.8
10	1980	75.2	2.1	52.8	9.4	40.9
11	1195	56.8	4.2	41.3	7.1	20.0
12	1315	75.6	LTD	50.7	6.4	38.7
13	1440	46.1	LTD	60.3	6.7	59.5

TABLE 5

URINARY HORMONE RESULTS CONTINUED

Subject 2	VOLUME	CORTISOL ug/TV	EPI ug/TV	NOR ug/TV	ALDO ug/TV	ADH mU/TV
F-21	2760	138.0	38.0	67.1	16.6	42.3
-20	1710	100.0	40.3	61.5	17.3	54.7
-19	1480	101.5	22.2	51.2	4.5	26.0
-18	1395	104.6	20.0	73.5	20.6	48.4
-17	2610	144.9	17.0	59.2	16.2	36.5
-16	1520	88.2	9.2	55.0	13.2	38.4
-15	1670	112.7	13.0	71.9	19.8	36.6
-14	1580	104.3	13.8	68.2	15.1	41.0
-13	860	16.8	22.3	117.1	8.0	18.8
-12	1380	151.1	19.0	72.3	5.3	41.4
-11	3030	92.4	21.6	62.7	17.4	33.9
-10	930	83.7	3.1	62.3	22.2	18.0
-9	1600	12.6	6.1	54.3	19.3	33.2
-8	1400	84.0	23.2	70.2	24.5	40.9
-7	1280	76.8	LTD	95.4	25.9	38.3
-6	2530	46.8	38.0	63.1	16.1	52.4
-5	1700	60.4	6.6	95.3	21.2	23.7
-4	1200	63.0	11.3	53.3	34.0	40.0
-3	1990	122.4	36.8	79.3	33.7	57.2
-2	680	46.6	14.5	54.3	18.7	18.9
-1	810	54.3	LTD	64.7	20.6	11.3
MEAN±SD	1625±645	86.0±38	17.9±12	69.1±16	18.6±8	35.1±15
BR1	2000	75.0	21.1	43.9	20.9	57.2
2	2615	83.7	19.0	31.4	19.8	43.5
3	1620	85.0	19.1	29.6	41.1	33.5
4	1970	101.5	13.9	37.9	41.4	55.0
5	1515	113.6	15.2	26.9	27.3	34.3
6	2050	143.5	14.2	64.4	38.4	48.0
7	1760	120.5	8.5	27.6	28.4	53.8
8	1670	112.7	7.4	29.9	27.6	56.6
9	2655	192.5	0.2	47.2	20.9	42.5
10	1670	40.9	6.9	22.5	25.5	37.7
11	1560	106.9	11.7	48.9	23.6	48.9

TABLE 5

URINARY HORMONE RESULTS CONTINUED

Subject 2	VOLUME	CORTISOL ug/TV	EPI ug/TV	NOR ug/TV	ALDO ug/TV	ADH mU/TV
BR12	1880	105.3	5.0	29.4	25.0	40.0
13	2325	131.4	24.8	21.5	20.9	57.4
14	2580	80.0	36.3	24.2	30.5	89.4
R+0	810	30.0	16.5	41.4	23.0	7.6
1	1030	29.9	12.1	64.5	22.7	28.3
2	1010	20.7	8.8	45.2	16.1	33.5
3	1360	44.2	29.3	33.3	17.4	30.0
4	1050	52.5	15.6	60.0	28.2	37.8
5	1840	156.4	23.1	49.9	23.5	51.7
6	2375	71.2	0.2	70.0	20.3	60.0
7	1520	53.2	13.9	62.1	38.5	39.4
8	1240	89.9	3.3	69.3	29.3	44.8
9	1185	80.0	LTD	85.6	12.7	37.1
10	1590	56.4	LTD	108.3	13.4	47.7
11	1220	54.9	16.4	60.1	12.3	77.8
12	2175	57.6	11.1	73.1	10.4	50.8
13	1870	105.7	LTD	135.0	16.9	65.0

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TABLE 5

URINARY HORMONE RESULTS CONTINUED

Subject 3	VOLUME	CORTISOL ug/TV	EPI ug/TV	NOR ug/TV	ALDO ug/TV	ADH mU/TV
F-21	1810	52.5	4.9	73.6	3.5	23.2
-20	1800	82.8	10.7	61.8	3.4	24.3
-19	2000	67.0	24.9	43.3	1.0	29.3
-18	1620	70.5	71.5	39.1	3.8	23.8
-17	1715	77.2	62.4	42.4	4.7	14.1
-16	1800	63.9	34.7	36.7	3.7	39.6
-15	2270	80.6	35.1	55.1	8.9	43.8
-14	1720	71.4	28.1	34.4	4.4	31.1
-13	2580	58.1	77.7	56.6	10.9	44.7
-12	2115	33.8	30.0	40.7	7.2	29.6
-11	2350	98.7	47.0	54.3	10.4	31.4
-10	1490	43.2	36.1	35.6	7.2	27.7
-9	1840	27.6	9.5	52.7	8.5	19.2
-8	2340	76.0	61.1	69.7	14.4	60.8
-7	1880	25.4	26.9	26.6	7.1	38.8
-6	2990	26.9	57.2	52.1	8.2	24.7
-5	1900	26.6	52.4	62.3	9.1	57.2
-4	2400	21.6	20.2	53.1	8.2	33.6
-3	1460	21.2	35.2	32.2	11.4	39.8
-2	1620	31.6	22.6	54.4	13.0	73.4
-1	1640	20.5	20.6	50.4	11.5	45.8
MEAN±SD	1969±392	51.3±25	36.6±21	48.9±13	7.6±4	43.7±18
BR1	2740	31.5	34.1	37.2	10.8	24.2
2	3450	63.8	28.2	42.4	13.2	37.7
3	1740	38.3	26.6	33.7	10.6	36.0
4	2270	124.9	42.6	30.6	14.7	34.7
5	2615	69.3	80.7	37.6	20.2	41.8
6	2340	90.1	43.1	74.1	19.8	48.4
7	2240	70.6	9.0	45.1	14.9	41.7
8	3120	166.9	10.4	55.8	22.7	64.8
9	2880	40.3	LTD	57.5	16.1	27.6
10	3020	19.6	5.9	40.4	13.4	23.3
11	2510	59.0	35.9	45.7	11.7	32.1

TABLE 5

URINARY HORMONE RESULTS CONTINUED

Subject 3	VOLUME	CORTISOL ug/TV	EPI ug/TV	NOR ug/TV	ALDO ug/TV	ADH mU/TV
BR12	2630	35.5	33.3	71.1	15.8	31.5
13	2425	59.4	36.9	22.9	7.1	20.1
14	3140	98.9	40.6	29.4	12.9	26.8
R+0	2180	52.3	41.2	33.8	18.1	46.4
1	1730	90.0	65.8	63.9	17.1	47.2
2	2180	117.7	35.9	85.2	15.6	52.2
3	1680	90.7	44.5	56.3	12.8	47.0
4	2230	27.9	48.6	67.8	15.8	34.3
5	2030	44.7	46.6	61.8	14.2	31.1
6	2235	57.0	LTD	124.0	13.5	43.2
7	1280	50.8	9.9	76.4	8.2	32.4
8	2245	76.3	9.7	67.3	19.2	45.0
9	2050	53.3	26.7	108.2	4.7	79.5
10	1820	22.8	35.9	84.0	5.4	30.3
11	1905	33.3	61.8	44.3	5.6	44.5
12	1090	52.3	14.8	90.3	7.7	57.7
13	1260	69.3	36.1	87.8	6.9	12.1

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TAB 5

URINARY HORMONE RESULTS CONTINUED

Subject 4	VOLUME	CORTISOL ug/TV	EPI ug/TV	NOR ug/TV	ALDO ug/TV	ADH mU/TV
F-21	925	76.3	3.2	46.5	18.9	19.8
-20	875	79.6	7.2	32.5	13.7	78.9
-19	1105	88.4	8.1	35.7	15.7	36.3
-18	1430	125.1	6.9	38.9	17.4	28.5
-17	1715	63.5	2.2	42.0	24.2	57.0
-16	1260	74.3	10.8	48.8	17.1	38.6
-15	1415	31.8	2.7	39.7	18.4	33.8
-14	2195	85.6	15.7	45.4	36.6	36.5
-13	1240	103.5	7.4	42.5	13.3	19.1
-12	1780	40.0	1.3	34.7	21.1	23.3
-11	1055	23.7	7.4	36.4	10.1	29.4
-10	1900	44.7	7.0	48.6	21.7	121.9
-9	1205	25.9	9.9	51.9	13.7	38.4
-8	1620	35.6	3.6	72.4	20.2	49.7
-7	940	31.0	11.8	28.8	13.4	27.1
-6	1160	51.0	30.3	57.5	25.2	16.2
-5	400	23.6	3.6	35.3	10.2	27.5
-4	1690	39.9	7.5	31.2	19.9	58.8
-3	970	35.4	11.9	27.2	19.9	28.6
-2	1750	93.6	4.4	39.0	21.4	51.5
-1	1720	110.1	12.1	33.1	20.3	71.3
MEAN±SD	1350±429	61.1±31	8.3±6	41.3±11	18.7±6	45.3±29
BR1	1490	62.5	14.2	22.6	27.3	54.5
2	610	68.3	7.8	14.3	15.8	48.4
3	740	70.3	6.2	33.1	20.4	17.6
4	1020	137.7	6.8	18.3	19.0	47.6
5	800	45.2	1.6	10.7	9.7	30.7
6	1345	104.2	LTD	29.9	27.6	36.0
7	960	79.2	0.3	21.3	18.2	23.0
8	650	87.8	0.4	17.3	15.8	41.3
9	760	93.1	2.1	20.3	27.2	24.0
10	1265	86.6	1.4	33.8	44.2	35.3

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URINARY HORMONE RESULTS CONTINUED

Subject 4	VOLUME	CORTISOL ug/TV	EPI ug/TV	NOR ug/TV	ALDO ug/TV	ADH mU/TV
BR11	1195	164.3	10.4	21.6	20.3	25.6
12	910	88.7	1.0	24.3	18.1	14.6
13	870	63.5	7.8	20.9	13.2	40.6
14	2210	116.0	8.4	19.9	18.4	108.8
R+0	670	127.3	15.7	28.4	23.9	30.6
1	780	50.7	12.9	32.8	18.5	31.2
2	1500	112.5	21.9	31.9	17.6	68.0
3	1905	138.1	4.1	41.6	18.0	47.0
4	2410	69.9	1.1	46.5	19.7	37.0
5	1635	95.6	LTD	61.1	19.4	65.4
6	1050	60.4	LTD	75.1	14.5	46.9
7	715	68.6	2.5	25.0	5.2	49.0
8	1610	84.5	0.3	42.5	9.2	55.6
9	1180	83.2	0.3	63.4	12.2	41.9
10	1120	61.6	LTD	66.2	14.2	38.3
11	1590	58.0	7.3	47.6	10.6	63.6
12	990	43.1	0.7	33.8	14.5	23.8
13	1370	113.0	LTD	54.7	10.7	51.5

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TABLE 5

URINARY HORMONE RESULTS CONTINUED

Subject 5	VOLUME	CORTISOL ug/TV	EPI ug/TV	NOR ug/TV	ALDO ug/TV	ADH mU/TV
F-21	1270	58.4	LTD	52.7	4.4	88.4
-20	1045	54.3	17.4	48.3	7.9	39.9
-19	1020	90.6	3.2	39.2	2.6	42.8
-18	1375	31.6	0.4	54.7	3.0	52.4
-17	1365	118.1	7.1	55.3	6.2	62.8
-16	1000	61.0	11.7	59.1	7.4	42.9
-15	1135	62.4	LTD	56.0	3.0	41.8
-14	900	64.8	LTD	61.4	5.4	28.8
-13	1030	45.8	LTD	83.9	5.0	29.7
-12	860	36.6	LTD	58.7	4.6	36.5
-11	1130	15.8	2.4	66.1	5.0	117.0
-10	1120	44.8	6.1	50.7	5.0	217.5
-9	1040	17.7	LTD	57.3	3.4	45.5
-8	1150	24.2	LTD	63.5	5.0	200.2
-7	1180	31.3	1.0	49.2	6.4	60.0
-6	980	34.8	20.3	87.6	13.4	44.2
-5	700	20.7	16.1	56.2	13.0	16.5
-4	675	10.5	11.9	26.7	6.5	48.6
-3	1010	32.3	13.9	40.2	9.8	29.5
-2	920	67.6	15.3	31.7	6.0	75.6
-1	1100	73.2	7.6	34.6	5.7	45.3
MEAN±SD	1048±180	47.5±27	6.4±7	54.0±15	6.1±3	78.0±66
BR1	1110	50.0	LTD	66.6	6.5	155.4
2	1075	45.7	6.3	41.3	4.2	165.6
3	870	51.7	6.8	46.6	7.0	40.6
4	920	24.4	3.1	16.4	2.1	128.1
5	1030	39.1	LTD	29.6	5.6	138.0
6	1365	81.9	LTD	51.3	29.3	41.0
7	1620	68.9	LTD	43.2	11.8	87.5
8	650	19.4	0.4	18.9	3.2	44.1
9	1030	49.4	LTD	34.3	11.2	40.0
10	1700	46.8	4.2	55.6	10.0	74.6

TABLE 5

URINARY HORMONE RESULTS CONTINUED

Subject 5	VOLUME	CORTISOL ug/TV	EPI ug/TV	NOR ug/TV	ALDO ug/TV	ADH mU/TV
BR11	1190	55.9	LTD	35.2	5.8	72.7
12	1160	81.2	6.6	31.2	7.6	37.0
13	1300	51.4	26.1	20.2	5.2	66.1
14	1190	32.7	7.8	25.0	3.8	82.2
R+0	900	62.1	10.9	40.4	11.4	56.4
1	950	35.2	LTD	69.9	6.3	41.6
2	1130	28.8	LTD	53.9	6.3	40.5
3	845	22.4	2.8	21.0	2.7	32.5
4	1360	34.7	LTD	58.8	7.8	56.4
5	880	49.7	2.4	34.4	4.5	59.0
6	960	37.0	0.2	92.0	7.2	101.1
7	1490	58.1	2.1	61.3	8.3	71.3
8	690	46.6	5.1	72.6	11.8	31.3
9	715	32.2	LTD	79.4	10.2	31.7
10	1250	68.8	LTD	93.9	6.3	415.0
11	910	47.8	LTD	66.0	3.2	51.2
12	760	45.6	LTD	88.2	4.0	36.2
13	610	41.8	LTD	97.7	7.3	31.2

TABLE 5

URINARY HORMONE RESULTS CONTINUED

Subject 6	VOLUME	CORTISOL ug/TV	EPI ug/TV	NOR ug/TV	ALDO ug/TV	ADH mU/TV
F-21	1450	183.4	11.3	62.4	10.8	19.0
-20	1295	114.6	9.4	47.9	0.8	29.2
-19	1280	66.6	4.8	40.3	5.6	33.2
-18	1050	49.4	3.4	58.4	14.5	20.3
-17	1160	63.8	5.4	44.3	9.5	24.6
-16	1080	54.0	20.1	64.8	13.6	25.2
-15	1425	44.9	5.9	72.1	17.2	47.5
-14	1765	105.9	12.4	60.9	12.5	34.2
-13	1110	55.5	13.6	44.9	14.3	19.2
-12	1340	77.0	LTD	47.9	21.9	33.8
-11	1035	34.7	12.5	48.5	14.3	24.8
-10	840	21.8	6.9	47.8	9.1	14.0
-9	1120	31.4	2.2	56.2	12.3	30.0
-8	1610	51.0	8.3	49.3	19.1	34.2
-7	1220	64.1	0.3	32.9	13.3	59.9
-6	1030	34.0	16.1	47.7	15.2	22.1
-5	880	28.2	6.1	27.7	12.1	40.1
-4	360	9.0	4.3	10.1	3.9	11.0
-3	880	26.0	12.9	27.5	11.4	33.0
-2	805	46.3	12.8	21.6	1.6	20.5
-1	1340	100.5	15.8	24.5	14.8	24.9
MEAN±SD	1146±308	60.1±40	8.8±6	44.7±16	11.8±5	29.0±13
BR1	1375	59.8	LTD	55.0	13.8	38.2
2	1065	54.8	11.4	45.1	12.8	79.5
3	1480	81.4	5.2	69.2	16.9	46.5
4	840	60.9	4.9	18.8	10.6	60.5
5	1730	79.6	2.7	27.0	12.9	96.6
6	810	45.4	LTD	26.9	16.8	38.9
7	1320	48.2	LTD	26.4	8.9	39.6
8	1270	106.0	LTD	47.9	16.8	37.4
9	1170	76.1	LTD	28.6	19.5	37.4
10	970	66.4	15.1	17.8	8.5	23.4

TABLE 5

URINARY HORMONE RESULTS CONTINUED

Subject 6	VOLUME	CORTISOL ug/TV	EPI ug/TV	NOR ug/TV	ALDO ug/TV	ADH mU/TV
BR11	1430	40.8	14.1	25.9	13.5	44.7
12	1200	28.2	5.0	21.5	12.1	16.8
13	1390	76.5	7.5	29.1	14.2	53.9
14	1445	59.2	7.5	21.7	11.3	27.4
R+0	1110	62.2	15.0	26.8	23.6	15,9
1	720	32.4	4.1	40.7	13.0	27.8
2	1260	34.7	1.0	33.9	9.3	62.2
3	1545	38.6	LTD	51.0	12.7	40.7
4	1370	28.0	0.1	59.2	14.7	56.4
5	810	72.9	LTD	52.3	19.4	18.4
6	860	50.3	1.8	27.7	7.6	17.7
7	1005	65.3	0.3	53.1	8.6	60.3
8	735	44.1	5.5	49.1	9.4	35.3
9	1015	60.9	LTD	54.0	7.5	59.8
10	1390	62.6	LTD	82.2	10.1	78.1
11	1130	60.5	1.1	61.3	6.3	42.0
12	1150	48.9	LTD	70.2	9.4	34.7
13	410	33.8	LTD	51.7	6.0	11.1

TABLE 6

BODY COMPARTMENT RESULTS

SUBJECT	1	2	3	6	4	5
			Total Body Water (Liter)			
BR -21	43.0	43.2	43.4	39.7	41.4	44.8
BR +14	42.1	43.1	43.3	40.5	41.8	44.1
R +13	46.5	43.3	44.4	40.5	41.3	45.0
			Extra Cellular Fluid (Liter)			
BR -21	16.9	16.3	18.2	15.0	14.6	17.0
BR +14	16.0	16.3	17.1	15.6	14.7	16.8
R +13	15.9	16.5	17.1	15.4	15.2	16.7
			Exchangeable Total Body Potassium (mEq)			
BR -21	3742	3666	3572	3171	3573	4027
BR +14	3670	3552	3630	3091	3668	3942

TABLE 7

BODY WEIGHT
(Kg)

Mean $\pm$ S.D.

SUBJECT	PRE	IN	POST
1	68.7$\pm$.3	69.1$\pm$.4	69.7$\pm$.4
2	71.0$\pm$.3	71.1$\pm$.3	70.8$\pm$.5
3	69.4$\pm$.5	69.6$\pm$.4	69.7$\pm$.3
4	64.6$\pm$.3	64.2$\pm$.3	64.0$\pm$.6
5	81.7$\pm$.7	81.6$\pm$.5	81.0$\pm$.7
6	64.4$\pm$.4	65.2$\pm$.9	65.6$\pm$.5

SUMMARY OF STATISTICAL RESULTS ON 24-HOUR URINE SAMPLES

(Paired t-test: 6 Day Means)

SUBSTANCE	LAST 6 DAYS PRE MEAN±SE	FIRST 6 DAYS IN MEAN±SE	P	SECOND 6 DAYS IN MEAN±SE	P
Volume	1321±99	1580±120	<0.1	1621±111	<0.1
SpGr	1.019±.001	1.017±.001	<0.4	1.017±.001	<0.5
Osmol	768±36	729±40	<0.5	732±37	>0.5
Na	188±10	233±10	≤0.01	225±8	<0.02
K	65±3	73±3	<0.01	77±4	<0.01
Cl	163±9	206±9	<0.005	201±8	<0.005
Ca	7.9±0.4	10.0±0.6	<0.05	10.8±0.4	<0.005
Mg	8.8±0.4	9.7±0.6	<0.40	10.6±0.5	<0.025
IPO_4	1020±40	1024±41	>0.5	1104±45	<0.20
Uric Acid	883±36	883±34	>0.5	960±30	<0.20
Creatinine	1958±62	1973±78	>0.5	2023±67	<0.50
Cortisol	45.6±4	71.7±5	<0.01	77.9±7	<0.01
Epinephrine	18.9±2	15.1±3	>0.2	6.4±1	<0.01
Norepinephrine	43.6±3	34.6±3	>0.2	33.8±2	>0.3
Aldosterone	14.1±1	17.2±2	≤0.05	17.1±1	≤0.05
ADH	38.6±3	55.1±6	<0.4	40.8±3	<0.8

BAYLOR BED REST STUDY PHASE I

MENU AND NUTRITIONAL BALANCE STUDIES

FOOD AND NUTRITION BRANCH
BIOMEDICAL RESEARCH DIVISION

INTRODUCTION

The Baylor University School of Medicine Bed Rest Study - Phase I was initiated as a result and in an attempt to elucidate the cause(s) of the variability in biological data obtained from humans in space travel. This variability in data could be attributed to either individual variability in nutrient utilization, individualistic development of a functional metabolic or dietary deficiency in essential ingestible nutrients and/or to a manifestation of the human organism in response when subjected to the weightless condition of space flight. To duplicate as closely as possible the organismic effects of space flight in a groundbased study subject to the gravitational forces, the individual must be subjected to a regimen of muscle inamination. This can be accomplished by subjecting the individuals to a regimen of total residence in a horizontal position for a specified period of time. Because of the physiologically significant questions posed by the Skylab missions, six (6) individuals were subjected to bedrest after undergoing the Skylab protocol of preflight and postflight feeding and biological sample collection in support of the M070 experimental series "Nutrition and Musculoskeletal Function."

In support of the Bed Rest Study - Phase I, menus were designed according to the Skylab nutritional requirements, utilizing Lot B Skylab foods. Menus were planned on a 6-day cycle for each of the 6 subjects, with the assumption that each subject repeated the menu cycle 9 times. These menus met the National Research Council requirements for nutrient requirements for adults. The pre-bed and post-bed menus were similar, but the in-bed menus with respect to energy values were decreased by 300 Calories/day.

Controlled nutrients included nitrogen, sodium, potassium, magnesium, calcium an chloride. Training of personnel performing the meal assembly, preparation, service, and residual food documentation were subjected to several training sessions.

Food and Nutrition Laboratory support was provided for the analysis of biological speciments obtained from the Bedrest Study - Phase I, by analyses, preparation, and/or storage of the samples. Analyses were performed for fecal nitrogen, calcium, phosphorus, magnesium, sodium, potassium, and chloride and urinary nitrogen. Complete details on the analytical procedures and data submission are given in Section III. Tabulation and calculation of the metabolic balance of the aforementioned nutrients was then accomplished.

Therefore, this document outlines the procedures utilized by the NASA-MSC Food and Nutrition Branch for supporting the Baylor College of Medicine Bed Rest Study - Phase I, during the pre-bed, bed, and post-bed phases of the study. Specific procedures used to support the M070 series of experimental protocol are given and include menu design, meal assembly, preparation, and service; residual food handling; collection and processing of feces, vomitus, and urine; sample storage and documentation; fecal and urine analytical procedures; data review; and summarization of the metabolic balance data.

MATERIAL AND METHODS

FOOD AND NUTRITION LABORATORY

Bedrest support was provided during the pre-bed, bed, and post-bed periods for the processing, storage, and analysis of feces and/or vomitus and the storage and analysis of urine specimens. Support requirements included the processing of feces and/or vomitus for laboratory analysis; laboratory analysis for nitrogen, phosphorus, calcium, potassium, sodium, magnesium, chlorides, and pH; storage of processed specimens; and data tabulation.

Analyses of urine nitrogen were made on 10 ml aliquots disbursed from the 24-hour pool obtained from each subject.

Collection of Biological Specimens

To facilitate the proper collection of feces and/or vomitus and urine specimens, a briefing of Baylor collection personnel was conducted by Dr. Wheeler (NASA) and Dr. Smith (T.I.). As a result, a detailed fecal and/or vomitus collection protocol were transmitted to Baylor. Urine bottles were supplied to the Baylor University School of Medicine at the start of the bedrest study for collection of individual urine specimens for inclusion into the 24-hour pool. A 10 ml aliquot of this 24-hour urine pool was supplied to the Food and Nutrition Laboratory for analysis. The Food and Nutrition Laboratory maintained the urine specimen at 4 $\pm$ 2°C prior to analysis and at -17 $\pm$ 2°C thereafter in storage.

Processing and Storage of Fecal and/or Vomitus Specimens

Processing and storage of fecal and/or vomitus samples was conducted in the Food and Nutrition Laboratory in Building 37, Room 1-125, NASA-JSC, on pre-bed, bed, and post-bed samples. A total of 243 fecal samples were

collected during the Baylor Bedrest Study-Phase I. No vomitus samples were received. All specimens were processed as follows, regardless of the origin.

Upon receipt of the fecal specimens at the Food and Nutrition Laboratory, Bldg. 37, Room 1-125, the plastic bag with the specimen within was removed from the fecal tub and the following information recorded into a bound notebook labeled Baylor Bedrest Study-Fecal Log Book:

1) Subject
2) Date of bowel movement
3) Time of bowel movement
4) Subjective color and description of physical appearance, i.e., solid, soft, diarrheal
5) Weight of sample plus plastic bag
6) Weight of plastic bag
7) Weight of fecal sample
8) Laboratory number

After logging in Steps 1-4, visible extraneous material such as tissue paper were removed and the fecal specimen weighed in the plastic bag on a top-loading balance (Mettler, Model P1200) to an accuracy of $\pm$0.1 g.

The specimen encased in the plastic bag was then kneaded to mix and pressed into a wafer-like mass of less than 1/2 inch thickness. The specimen was then frozen by placing in a -20 $\pm$ 5°C freezer. Accumulated frozen fecal specimens were placed in the Virtis freeze-drying apparatus on Monday and Thursday of each week and removed on the following Thursday and Monday, respectively. Procedures for start-up and shut-down of the freeze-dryer are given.

RESULTS AND DISCUSSION

In support of the Baylor Bed Rest Phase I study, various elemental compounds were determined as to intake, excretion, and retention. These elemental determinations included water, sodium, calcium, potassium, chloride, magnesium, nitrogen, and phosphorus.

The six subjects exposed to the experimental regimen had positive water balances, with water intake exceeding urinary and fecal water excretion.

The calcium balance of the six subjects was negative in the total time of the bed rest study. The physiologic effects of the continued loss of endogenous calcium by these individuals and the effects on various homostatic mechanisms has not been elucidated. The continual degradational loss in calcium from the individual subjects tends to verify the results previously obtained from crewmen of the Skylab missions. Under the conditions of this study, no relationship existed between water excretion and the elimination of calcium. However, urinary calcium excretion was increased during the bedrest phase of the study. Similarly, the source and level of intake of Vitamin D and relative intake of certain constituents of proteinaceous nature by altering the gastro-intestinal uptake and the disuse atrophy of masculature may have contributed to the endogenous calcium loss exceeding the ingestion of the calcium nutrient.

Sodium balance was not changed by subjecting the individuals to the experimental regimen. As the subjects were in positive water balance the positive electrolytes balance, which includes potassium and chloride, in addition to sodium, indicates that no significant average effect on the physiological homeostasis of the individual has occurred.

A positive magnesium balance was observed in the individual subjects during all phases of the Bed Rest Study. No detectable changes in the metabolism of magnesium were found, but as a result of the negative calcium balance, a potential exists for a magnesium metabolic alteration. These results tend to agree with the results previously submitted for the Skylab and Apollo missions. The importance of the positive magnesium balance in the subjects undergoing negative calcium balance is augmented by the magnesium regulation of renal calcium transport, in conjunction with Vitamin D.

Nitrogen balance, as an indicator of muscular physiology, was positive in the subjects. No change was detected during each of the three phases of the study.

Phosphorus intake was greater than phosphorus excretion in the subjects being studied during the prebed phase of the study. However, as the laboratory analyses of phosphorus has not been completed, no further trend implications could be deducted.

The preliminary nature of the data presented is emphasized. Further evaluation of the data must be accomplished before definitive statements as to the pertinence of certain elemental trends may be made.

BAYLOR BED REST - PHASE I

Body Weights (Kg)

SUBJECTS

STUDY DAY	1 BODY WT	2 BODY WT	3 BODY WT	6 BODY WT	4 BODY WT	5 BODY WT
PRE-						
01	68.6	71.1	69.3	63.6	64.8	82.3
02	68.5	71.1	69.3	64	64.9	82.7
03	68.2	70.9	69.1	64.4	65	81.8
04	68.9	71.2	69.5	63.7	64.5	82.7
05	69.1	71.7	71.1	64	65	82.7
06	69.1	71	69.8	64.9	64.9	82.7
07	68.4	70.7	68.9	64.1	65	81.8
08	68.5	71	69.7	64.5	65	82.3
09	68.6	71	69.7	64.4	64.5	81.5
10	68.8	70.9	69	64.7	64.4	88.9
11	69.1	71.8	69.8	64.7	64.3	81.7
12	69.1	70.6	69.5	64.2	64.5	82.3
13	69	71.1	69.5	64.7	64.4	81.1
14	68.9	71.1	69.9	64.4	64.4	81
15	68.4	68.4	69.5	64	64.3	80.9
16	68.4	70.8	69.5	64.1	64.5	80
17	68.8	70.7	68.4	64.1	64.4	80.5
18	68.9	70.5	69.5	64.7	64.4	81.6
19	68.6	70.5	69.1	64.7	64.7	81.6
20	68.2	71	69.1	64.9	64.7	81.8
21	69.3	71	69.5	64.8	64.2	81.6
MEAN	68.7381	70.8381	69.4619	64.3619	64.6095	81.6904
SDEV	.321825	.652832	.514087	.385758	.265024	.763762
SIZE	21	21	21	21	21	21
SUM	1443.50	1487.60	1458.70	1351.60	1356.80	1715.50

BAYLOR BED REST - PHASE I

Body Weights (Kg)

SUBJECTS

	1	2	3	6	4	5
STUDY DAY	BODY WT	BODY WT	BODY WT	BODY WT	BODY WT	BODY WT
BED						
01	69.5	71.1	69.5	64.8	64.2	81.1
02	69.5	71.5	69	64.4	63.5	80.7
03	68.4	71.5	69	64.7	64	80.9
04	68.5	71.5	69.5	65.2	64.7	81.5
05	68.8	71.1	69.4	65.2	64.6	81.6
06	69	71.2	69.1	65.3	64.3	81.8
07	69.2	70.6	69.5	65.3	64.2	82.5
08	69.4	71	69.9	65.4	64.2	81.9
09	69.5	71	69.5	65.1	64.2	82
10	69.6	70.5	69.9	65.7	64.3	82
11	69.2	70.8	69.9	66	64.4	81.6
12	69.2	71	69.9	66.1	64.2	81.5
13	68.9	71	69.9	66.9	64.1	82.1
14	69	70.8	70.2	66.8	64.2	81.8
MEAN	691214	71.0500	69.5857	65.3500	64.2214	81.6357
SDEV	.374312	.314485	.374312	.505464	.274862	.488887
SIZE	14	14	14	14	14	14
SUM	967.700	994.700	974.200	914.900	899.100	1142.90

BAYLOR BED REST - PHASE I

Body Weights (Kg)

SUBJECTS

STUDY DAY	1 BODY WT	2 BODY WT	3 BODY WT	6 BODY WT	4 BODY WT	5 BODY WT
POST						
01	69.1	71.1	70	65.7	64.7	82
02	69.4	71.25	69.4	65.7	64.8	82.3
03	69.5	71.1	69.9	65.5	64.4	81.9
04	70	71.5	69.8	65.8	64.7	81.5
05	69.5	70.7	69.8	65.7	63.8	80.9
06	70	71.4	69.8	64.2	62.8	80.2
07	69.7	70.9	70	65.5	63.6	80.6
08	70	70.1	70	65.5	63.9	80.5
09	70	70.1	70	65.5	63.6	80.5
10	69.8	70.2	69.4	66	64.1	80.7
11	68.9	70.3	69.4	66.5	64.2	81.2
12	69.5	70.6	69.7	65.8	63.9	80.5
13	70	70.7	69.3	65.5	63.6	80.5
14	69.9	70.7	69.3	65.5	63.4	79.3
MEAN	69.6643	70.7607	69.7000	65.6000	63.9643	80.8999
SDEV	.357417	.470269	.274862	.487480	.566946	.806906
SUM	975.300	990.650	975.800	918.400	895.500	1132.60

BAYLOR BED REST STUDY - PHASE I
Body Weight, Fecal Weight, Water Balance & Nitrogen Balance
Statistics

SUBJECT: 1

STUDY DAY: TOTAL BED REST STUDY

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	69.1122	117.740	1290.67	2.11326
SDEV	.515078	53.9276	738.767	2.46889
SIZE	49	44	49	49
SUM	3386.50	5180.60	63243.2	103.550

STUDY DAY: PRE 01 TO PRE 21

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	68.7381	108.333	1510.20	2.38524
SDEV	.321825	46.5546	743.172	2.28737
SIZE	21	21	21	21
SUM	1443.50	2275.00	31714.2	50.0900

STUDY DAY: BED 01 TO BED 14

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	69.1214	117.433	786.142	1.49642
SDEV	.374312	47.1963	529.250	3.03882
SIZE	14	9	14	14
SUM	967.700	1056.90	10306.0	20.9500

STUDY DAY: POST 01 TO POST 14

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	69.6643	132.050	1515.92	2.32214
SDEV	.357417	67.4592	649.397	2.15549
SIZE	14	14	14	14
SUM	975.300	1848.70	21223.0	32.5100

BAYLOR BED REST - PHASE I
Mineral Statistics

SUBJECT: 1
STUDY DAY: TOTAL BED REST STUDY

	CA-DELTA	P-DELTA	NA-DELTA	K-DELTA	MG-DELTA	CL-DELTA
MEAN	-24.3133	243.735	36.8420	12.5904	8.37714	37.9404
SDEV	353.339	317.122	58.4395	17.6511	8.70576	54.2300
SIZE	49	24	49	49	49	49
SUM	-1191.35	5849.65	1805.26	616.930	410.480	1859.08

STUDY DAY: PRE 01 TO PRE 21

	CA-DELTA	P-DELTA	NA-DELTA	K-DELTA	MG-DELTA	CL-DELTA
MEAN	58.6838	128.823	46.5357	17.6709	8.74524	45.9438
SDEV	259.265	233.154	60.2265	16.0485	12.1312	54.5148
SIZE	21	19	21	21	21	21
SUM	1232.35	2447.65	977.250	371.090	183.650	964.820

STUDY DAY: BED 01 TO BED 14

	CA-DELTA	P-DELTA	NA-DELTA	K-DELTA	MG-DELTA	CL-DELTA
MEAN	-102.692	680.399	18.4078	7.17642	8.55500	22.1771
SDEV	497.040	180.456	57.7652	19.9449	5.91475	53.1722
SIZE	14	5	14	14	14	14
SUM	-1437.70	3402.00	257.710	100.470	119.770	310.480

STUDY DAY: POST 01 TO POST 14

	CA-DELTA	P-DELTA	NA-DELTA	K-DELTA	MG-DELTA	CL-DELTA
MEAN	-70.4293	0	40.7357	10.3835	7.64714	41.6985
SDEV	300.805	0	56.2015	16.6683	4.19748	55.4350
SIZE	14	0	14	14	14	14
SUM	-986.010	0	570.300	145.300	107.060	583.780

BAYLOR BED REST - PHASE I
Water Balance (ml)

SUBJECT: 1

STUDY DAY	JUL DAY	W=IN	W-FECAL	W-URINE	W-DELTA
PRE 01	119	4151	77.72	2215	1858.28
02	120	2467	82.12	1655	729.88
03	121	3827	137.2	800	2889.8
04	122	2744	40.63	915	1788.37
05	123	3162	67.16	2180	914.84
06	124	3613	81.34	1280	2251.66
07	125	2727	84.47	1770	872.53
08	126	3002	104.66	1760	1137.34
09	127	4267	56	1800	2411
10	128	2811	26.41	1720	1064.59
11	129	3331	137	1380	1814
12	130	2422	47	1120	1255
13	131	2159	97	1510	552
14	132	2184	48	1535	605
15	133	3751	59	1260	2432
16	134	3364	83	1775	1506
17	135	2373	171	1540	662
18	136	2012	54	1080	878
19	137	3078	82	1780	1216
20	138	3527	88	1320	2119
21	139	3670	58	855	2757
BED 01	140	2896	78	2180	638
02	141	3011	ND	3230	-219
03	142	2163	ND	1400	763
04	143	2118	ND	1450	668
05	144	1883	ND	930	953
06	145	3169	160	1100	1909
07	146	2473	64	1580	829
08	147	1923	72	1560	291
09	148	2297	45	2345	-93
10	149	2143	ND	1400	743
11	150	2364	66	1380	918
12	151	3324	62	1930	1332
13	152	2321	73	1505	743
14	153	2454	103	1520	831
POST					
01	154	2710	72	1250	1388
02	155	2649	27	1230	1392
03	156	2747	52	925	1770
04	157	3871	97	1660	2114
05	158	3588	145	1860	1583
06	159	3393	89	2920	383
07	160	3370	33	1795	1542
08	161	2832	70	2070	692
09	162	2898	80	1880	938
10	163	5233	101	2410	2722
11	164	4421	183	1980	2258
12	165	3436	70	1195	2171
13	166	2584	167	1315	1182
14	167	2803	195	1440	1168

BAYLOR BED REST - PHASE I
Calcium Balance (mg)

SUBJECT: 1

STUDY	DAY	JUL DAY	CA-IN	CA-FECAL	CA-URINE	CA-DELTA
PRE	01	119	772	246.83	244.49	280.7
	02	120	791	494.31	325	-27.9
	03	121	791	825.07	212	-246.5
	04	122	786	276.73	269	240.7
	05	123	808	400.58	265	142.9
	06	124	784	451.54	429	-96.4
	07	125	801	272.87	248	279.6
	08	126	801	200.38	241	360
	09	127	817	141.9	854	-178.6
	10	128	792	70.73	220	500.8
	11	129	818	457.74	305	55.6
	12	130	793	215.1	228	349.1
	13	131	808	313.87	329	165.5
	14	132	788	509.89	325	-46.5
	15	133	795	562	236	-3.47
	16	134	802	620	305	-122.6
	17	135	801	1181	236	-616.47
	18	136	785	372	188	224.6
	19	137	797	665	309	-176.6
	20	138	801	678	216	-93.4
	21	139	795	373.5	180	241
BED	01	140	799	585	417	-202.8
	02	141	826	ND	497	329
	03	142	784	ND	228	555
	04	143	789	ND	317	472
	05	144	782	ND	257	525
	06	145	788	1646.9	325	-1183.5
	07	146	794	733.9	497	-437
	08	147	794	813.6	361	-380
	09	148	783	520.7	401	-138.5
	10	149	792	ND	421	371
	11	150	827	805	377	-355
	12	151	792	611.6	365	-184
	13	152	781	712.2	365	-292.9
	14	153	810	990.6	333	-513
POST	01	154	777	639.5	385	-247
	02	155	792	233.02	325	233.98
	03	156	806	598.7	232	-25.2
	04	157	811	765.6	409	45.4
	05	158	775	1096.8	381	-702.6
	06	159	830	594.4	377	-141.4
	07	160	788	214.8	353	220.2
	08	161	809	553.6	240	15.4
	09	162	818	609.6	232	-23.6
	10	163	780	699.5	345	-264.5
	11	164	776	1138.1	257	-619.1
	12	165	791	282.49	228	280.51
	13	166	774	448.9	244	81.1
	14	167	797	452.2	184	160.8

BAYLOR BED REST - PHASE I
Sodium Balance (mEq)

SUBJECT: 1

STUDY	DAY	JUL DAY	NA-IN	NA-FECAL	NA-URINE	NA-DELTA
PRE	01	119	286	3.26	216	66.75
	02	120	282	1.78	348	-67.78
	03	121	287	3.463	149	134.54
	04	122	288	.84	214	73.16
	05	123	288	1.93	334	-47.93
	06	124	244	2.07	140	101.93
	07	125	243	2.4	250	-9.4
	08	126	245	5.61	241	-1.61
	09	127	290	1.2	210	78.8
	10	128	287	.78	236	50.22
	11	129	293	4.9	204	84.1
	12	130	245	1.38	165	78.62
	13	131	244	1.88	238	4.12
	14	132	245	.96	287	-42.96
	15	133	283	1.09	170	111.91
	16	134	298	1.74	257	39.26
	17	135	290	3.22	234	52.78
	18	136	252	.89	215	36.11
	19	137	234	1.34	233	-.34
	20	138	246	1.09	167	77.91
	21	139	273	.94	115	157.06
BED	01	140	290	1.47	346	-57.47
	02	141	290	ND	392	-102
	03	142	244	ND	191	53
	04	143	243	ND	247	-4
	05	144	273	ND	196	77
	06	145	286	3.58	184	98.42
	07	146	288	1.19	229	67.81
	08	147	292	1.73	259	31.27
	09	148	219	.95	287	-68.95
	10	149	243	ND	210	33
	11	150	275	1.14	255	18.86
	12	151	282	.93	244	37.07
	13	152	287	1.72	241	44.28
	14	153	290	2.58	258	29.42
POST	01	154	243	.99	130	112.01
	02	155	234	.44	175	58.56
	03	156	283	1.1	172	109.9
	04	157	290	1.74	262	26.26
	05	158	287	3.57	199	84.43
	06	159	289	2.41	298	-11.41
	07	160	241	1	224	16
		161	246	1.91	268	-23.91
		162	276	2.04	232	41.96
		163	283	2.84	354	-73.84
		164	283	6.55	189	87.45
		165	269	1.2	158	109.8
		166	246	6.22	223	16.79
		167	235	7.7	211	16.3

BAYLOR BED REST - PHASE I
Potassium Balance (mEq)

SUBJECT: 1

STUDY	DAY	JUL DAY	K-IN	K-FECAL	K-URINE	K-DELTA
PRE	01	119	87	6.82	60	20.18
	02	120	101	11.75	83	6.25
	03	121	94	12.86	63	18.14
	04	122	108	4.94	81	22.06
	05	123	101	8.95	79	13.05
	06	124	91	9.4	46	35.6
	07	125	91	10.86	73	7.14
	08	126	103	10.52	97	-4.52
	09	127	104	8.68	67	28.32
	10	128	112	4.53	57	50.42
	11	129	110	20.97	51	38.03
	12	130	90	7.45	65	17.55
	13	131	89	13.12	91	-15.12
	14	132	99	6.19	89	3.9
	15	133	95	8.78	68	18.22
	16	134	112	13.65	82	16.35
	17	135	101	22.45	69	9.55
	18	136	90	6.17	78	5.83
	19	137	88	10.27	69	8.73
	20	138	101	11.36	65	24.64
	21	139	95	7.23	41	46.77
BED	01	140	108	10.96	76	21.04
	02	141	104	ND	81	23
	03	142	91	ND	52	39
	04	143	87	ND	-12	
	05	144	98	ND	66	32
	06	145	89	25.93	72	-8.93
	07	146	107	9.79	98	-.79
	08	147	97	11.41	64	19.59
	09	148	84	7.58	101	-24.58
	10	149	87	ND	59	28
	11	150	94	9.67	95	-10.67
	12	151	92	9.42	87	-4.42
	13	152	107	12.3	84	10.7
	14	153	96	19.47	88	-11.47
POST	01	154	89	11.1	88	-10.1
	02	155	87	3.19	90	-6.19
	03	156	94	8.27	67	18.73
	04	157	100	14.57	83	2.43
	05	158	118	26.54	63	20.46
	06	159	100	8.28	58	28.13
	07	160	92	4.27	56	31.73
	08	161	91	9.67	62	19.33
	09	162	98	11.83	77	9.17
	10	163	93	16.48	89	-12.48
	11	164	111	24.15	61	25.85
	12	165	86	9.88	47	29.12
	13	166	85	18.93	61	5.07
	14	167	88	18.88	85	-15.88

BAYLOR BED REST - PHASE I
Chloride Balance (mEq)

SUBJECT: 1

STUDY	DAY	JUL DAY	CL-IN	CL-FECAL	CL-URINE	CL-DELTA
PRE	01	119	255	1.36	175	78.64
	02	120	221	1.11	281	-61.11
	03	121	250	1.18	118	130.82
	04	122	261	.32	157	103.68
	05	123	267	.65	294	-27.65
	06	124	217	.94	153	63.06
	07	125	238	.81	220	17.19
	08	126	222	1,73	236	-15.73
	09	127	256	.93	184	71.07
	10	128	260	.7	229	30.3
	11	129	270	3.52	182	84.48
	12	130	217	1.76	143	72.24
	13	131	239	3.71	217	18.29
	14	132	222	.32	255	-33.32
	15	133	251	.39	158	92.61
	16	134	270	.77	261	8.23
	17	135	267	1.91	202	63.09
	18	136	223	.46	192	30.54
	19	137	229	.97	210	18.03
	20	138	223	1.02	149	72.98
	21	139	241	.62	93	147.38
BED	01	140	263	.88	294	-31.88
	02	141	268	ND	368	-100
	03	142	217	ND	169	48
	04	143	238	ND	213	25
	05	144	246	ND	184	62
	06	145	253	1.01	178	73.99
	07	146	261	.38	183	77.62
	08	147	270	.3	211	58.7
	09	148	192	.19	253	-61.19
	10	149	239	ND	175	64
	11	150	251	2.87	237	11.13
	12	151	250	.57	237	12.43
	13	152	260	.63	212	47.37
	14	153	258	.69	234	23.31
POST	01	154	216	.58	145	70.42
	02	155	229	.27	159	69.73
	03	156	259	.37	162	96.63
	04	157	253	1.09	239	12.91
	05	158	260	1.49	192	66.51
	06	159	254	.92	254	-.92
	07	160	213	.39	194	18.61
	08	161	234	.73	234	-.73
	09	162	252	.92	222	28.08
	10	163	229	1.17	325	-97.17
	11	164	256	2.04	172	81.96
	12	165	236	.73	139	123.3
	13	166	219	2.12	187	29.88
	14	167	227	2.44	140	84.57

BAYLOR BED REST - PHASE I
Magnesium Balance (mEq)

SUBJECT: 1

STUDY	DAY	JUL DAY	MG-IN	MG-FECAL	MG-URINE	MG-DELTA
PRE	01	119	29	2.72	12.6	13.68
	02	120	29	6.19	63.6	-40.79
	03	121	30	10.17	10.8	9.03
	04	122	30	3.1	11.8	15.1
	05	123	27	5.74	13.5	7.76
	06	124	26	6.63	7.9	10.47
	07	125	29	6.85	10.9	11.25
	08	126	29	5.73	9.5	13.77
	09	127	35	4.78	13	17.22
	10	128	31	2.28	12.5	16.22
	11	129	29	13.56	12.5	2.94
	12	130	25	5.81	11	8.19
	13	131	28	8.46	10.6	8.94
	14	132	29	6.3	15.1	7.6
	15	133	31	8.35	8.9	13.75
	16	134	31	9.05	10.2	11.75
	17	135	27	15.92	9.5	1.58
	18	136	25	4.56	7.9	12.54
	19	137	29	7.32	10.3	11.38
	20	138	29	8.67	8.2	12.13
	21	139	31	4.96	6.9	19.14
BED	01	140	30	8.01	13.4	8.59
	02	141	27	ND	12.7	14.3
	03	142	25	ND	8.3	6.7
	04	143	28	ND	14.4	13.6
	05	144	28	ND	9.8	18.2
	06	145	30	21.36	7.4	1.24
	07	146	29	9.75	8.6	10.65
	08	147	25	10.99	13	1.01
	09	148	23	7	13	3
	10	149	28	ND	9.3	18.7
	11	150	31	10.47	14.3	6.23
	12	151	31	8.37	13.7	8.93
	13	152	29	9.89	12.6	6.51
	14	153	26	14.09	9.8	2.11
POST	01	154	24	8.84	10.3	4.86
	02	155	29	3.13	8.6	17.27
	03	156	27	6.75	11.5	8.75
	04	157	32	10.81	12.9	8.29
	05	158	28	15.31	9.8	2.89
	06	159	28	8.28	13.3	6.42
	07	160	25	3.1	11.2	10.7
	08	161	28	7.95	10.5	9.55
	09	162	28	7.17	10.9	9.93
	10	163	30	9.61	13.8	6.59
	11	164	28	15.84	11.1	1.06
	12	165	25	.73	12.3	7.35
	13	166	24	10.68	11	2.32
	14	167	28	9.22	7.7	[illegible]

BAYLOR BED REST - PHASE 1
Nitrogen Balance (gm)

SUBJECT: 1

STUDY DAY	JUL DAY	N-IN	N-FECAL	N-URINE	N-DELTA
PRE 01	119	17.82	1.85	13.6	3.17
02	120	17.89	1.78	15	1.11
03	121	17.97	2.87	12.6	2.5
04	122	18.4	.95	13.7	3.75
05	123	17.5	1.4	16.2	-.10
06	124	16.22	1.63	10.1	4.49
07	125	17.28	2.22	16.9	-1.84
08	126	17.89	1.86	14.1	1.93
09	127	18.93	1.61	15.8	1.52
10	128	18.32	.85	11.1	6.37
11	129	17.57	3.22	11.2	3.15
12	130	16.19	1.54	13.5	1.15
13	131	17.22	2.22	14.3	.7
14	132	18.05	1.63	17.2	-.78
15	133	18.06	1.82	11.93	4.31
16	134	18.27	2.06	14.45	1.76
17	135	17.62	3.74	13	.88
18	136	16.48	1.2	11.96	3.32
19	137	17.33	2.03	13.42	1.88
20	138	18.05	2.07	13.26	2.72
21	139	18.06	1.26	8.7	8.1
BED 01	140	18.4	1.94	15.63	.83
02	141	17.38	ND	12.89	4.49
03	142	16.22	ND	8.81	7.41
04	143	17.26	ND	16.2	1.06
05	144	19.95	ND	13.85	6.1
06	145	18.14	4.09	12.77	1.28
07	146	18.16	1.76	16.83	-.43
08	147	17.14	2.15	13.67	1.32
09	148	16.14	1.42	17.52	-2.8
10	149	17.28	ND	13.5	3.78
11	150	20.22	2.1	17.18	.94
12	151	18.14	1.69	16.89	-.44
13	152	18.16	1.94	15.62	.6
14	153	16.17	2.87	16.49	-3.19
POST					
01	154	16.14	1.95	14.9	-.71
02	155	17.38	.65	14.4	2.33
03	156	20.06	1.54	14.13	4.39
04	157	18.14	2.16	14.71	1.27
05	158	18.16	3.18	14.84	.14
06	159	16.42	1.92	14.45	.05
07	160	15.98	.77	11.02	4.19
08	161	17.65	2.77	12.77	2.11
09	162	20.3	1.78	10.89	7.63
10	163	18.38	2.28	13.28	2.82
11	164	18	4.08	13.44	.48
12	165	16.26	1.55	11.65	3.06
13	166	16.3	2.89	11.03	2.38
14	167	17.49	2.45	12.67	2.37

BAYLOR BED REST - PHASE I
Phosphorus Balance (mg)

SUBJECT: 1

STUDY	DAY	JUL DAY	P-IN	P-FECAL	P-URINE	P-DELTA
PRE	01	119	1629	215.28	1108	305.72
	02	120	1669	449.87	1192	27.13
	03	121	1669	696.82	960	12.18
	04	122	1721	213.3	1226	281.7
	05	123	1583	344.59	1046	192.41
	06	124	1616	416.07	819	308.93
	07	125	1576	619.79	885	71.21
	08	126	1771	514.34	1056	200.66
	09	127	1795	688.16	1188	-61.16
	10	128	1713	239.17	722	751.83
	11	129	1619	891.09	718	-120.09
	12	130	1617	576.23	1098	-57.23
	13	131	1572	588.58	1087	-103.58
	14	132	1781	439.69	1289	75.15
	15	133	1706	533.48	857	315.52
	16	134	1723	587.66	994	191.31
	17	135	1610	1023.71	924	-337.71
	18	136	1631	321.12	1037	272.88
	19	137	1563	560.21	961	120.79
	20	138	1790	TF	976	TF
	21	139	1704	TF	752	TF
BED	01	140	1726	TF	1134	TF
	02	141	1602	ND	969	633
	03	142	1616	ND	672	944
	04	143	1562	ND	1102	460
	05	144	1832	ND	1079	753
	06	145	1683	TF	836	TF
	07	146	1701	TF	1201	TF
	08	147	1552	TF	874	TF
	09	148	1587	TF	1313	TF
	10	149	1564	ND	952	612
	11	150	1838	TF	1352	TF
	12	151	1687	TF	1235	TF
	13	152	1694	TF	1294	TF
	14	153	1652	TF	1216	TF
POST	01	154	1607	TF	950	TF
	02	155	1559	TF	175	TF
	03	156	1838	TF	1240	TF
	04	157	1718	TF	1328	TF
	05	158	1712	TF	1004	TF
	06	159	1680	TF	1226	TF
	07	160	1611	TF	754	TF
	08	161	1613	TF	994	TF
	09	162	1880	TF	865	TF
	10	163	1718	TF	1253	TF
	11	164	1702	TF	1183	TF
	12	165	1631	TF	932	TF
	13	166	1595	TF	999	TF
	14	167	1591	TF	211	TF

BAYLOR BED REST STUDY - PHASE I
Body Weight, Fecal Weight, Water Balance & Nitrogen Balance
Statistics

SUBJECT: 2

STUDY DAY: TOTAL BED REST STUDY

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	70.8765	171.405	1283.03	1.04306
SDEV	.526508	56.0195	802.329	1.93897
SIZE	49	46	49	49
SUM	3472.95	7884.67	62868.8	51.1100

STUDY DAY: PRE 01 TO PRE 21

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	70.8381	176.972	1429.23	.79485
SDEV	.652832	57.0253	879.070	2.08485
SIZE	21	19	21	21
SUM	1487.60	3362.47	30013.8	16.6800

STUDY DAY: BED 01 TO BED 14

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	71.0500	140.750	746.642	.728571
SDEV	.314485	51.8403	496.132	2.10552
SIZE	14	12	14	14
SUM	994.700	1689.00	10453.0	10.2000

STUDY DAY: POST 01 TO POST 14

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	70.6707	188.142	1600.14	1.73071
SDEV	.470269	53.0319	699.406	1.33769
SIZE	14	14	14	14
SUM	990.650	2634.00	22402.0	24.2300

BAYLOR BED REST - PHASE I
Mineral Statistics

SUBJECT: 2

STUDY DAY: TOTAL BED REST STUDY

	CA-DELTA	P-DELTA	NA-DELTA	K-DELTA	MG-DELTA	CL-DELTA
MEAN	-146.374	103.308	18.3871	5.99010	7.80531	12.1343
SDEV	255.969	241.176	56.3632	15.1858	5.11554	56.6481
SIZE	49	21	49	49	49	49
SUM	-7172.34	2169.48	900.971	293.515	382.460	594.580

STUDY DAY: PRE 01 to PRE 21

	CA-DELTA	P-DELTA	NA-DELTA	K-DELTA	MG-DELTA	CL-DELTA
MEAN	-78.9405	68.0252	21.7702	6.61429	8.18643	16.9728
SDEV	266.371	225.457	67.6875	15.7941	5.25992	67.4908
SIZE	21	19	21	21	21	21
SUM	-1657.75	1292.48	457.174	138.900	171.915	356.430

STUDY DAY: BED 01 TO BED 14

	CA-DELTA	P-DELTA	NA-DELTA	K-DELTA	MG-DELTA	CL-DELTA
MEAN	-232.810	438.500	6.98785	1.54285	7.65429	-1.174
SDEV	317.306	2.12131	43.6765	17.5688	4.45717	43.4992
SIZE	14	2	14	14	14	14
SUM	-3259.34	877.000	97.8300	21.6000	107.160	-16.43

STUDY DAY: POST 01 TO POST 14

	CA-DELTA	P-DELTA	NA-DELTA	K-DELTA	MG-DELTA	CL-DELTA
MEAN	-161.089	0	24.7119	9.50107	7.38464	18.1850
SDEV	128.274	0	50.7147	11.1282	5.80885	51.7761
SIZE	14	0	14	14	14	14
SUM	-2255.25	0	345.967	133.015	103.385	254.590

BAYLOR BED REST - PHASE I
Water Balance (ml)

SUBJECT: 2

STUDY	DAY	JUL DAY	W-IN	W-FECAL	W-URINE	W-DELTA
PRE	01	119	4349	ND	2760	1589
	02	120	3030	218.31	1710	1101.69
	03	121	4139	ND	1400	2739
	04	122	2588	69.68	1395	1123
	05	123	3120	135.84	2610	374.16
	06	124	2809	89.88	1520	1199
	07	125	2699	216.01	1670	813
	08	126	2758	133.6	1580	10.44
	09	127	4174	168	860	3146
	10	128	2947	100	1380	1467
	11	129	3209	192	3030	-13
	12	130	2587	121	930	1536
	13	131	2784	177	1600	1007
	14	132	2594	181.86	1400	1012
	15	133	3380	200	1280	1900
	16	134	2997	100	2530	367
	17	135	2650	145	1700	805
	18	136	2971	99	1200	1672
	19	137	3334	95	1990	1249
	20	138	3904	179	680	3045
	21	139	3720	72	810	2838
BED	01	140	2779	156	2000	623
	02	141	3120	ND	2615	505
	03	142	2651	NS	1620	1031
	04	143	2370	87	1970	313
	05	144	2464	80	1515	869
	06	145	3243	146	2050	1047
	07	146	2900	84	1760	1056
	08	147	2656	80	1670	906
	09	148	2289	162	2655	-528
	10	149	3052	53	1670	1329
	11	150	2493	158	1560	775
	12	151	3462	121	1880	1461
	13	152	3156	118	2325	713
	14	153	2976	43	2580	353
POST	01	154	2857	189	810	1585
	02	155	2705	113	1030	1562
	03	156	3149	138	1010	2001
	04	157	4179	194	1360	2625
	05	158	4197	147	1050	3000
	06	159	3110	157	1840	1113
	07	160	2856	180	2375	301
	08	161	2839	116	1520	1203
	09	162	2925	179	1240	1506
	10	163	3438	184	1185	2069
	11	164	3415	32	1580	1803
	12	165	3023	126	1220	1677
	13	166	3181	194	2175	812
	14	167	3205	190	1870	1145

BAYLOR BED REST - PHASE I
Calcium Balance (mg)

SUBJECT: 2

STUDY	DAY	JUL DAY	CA-IN	CA-FECAL	CA-URINE	CA-DELTA
PRE	01	119	772	ND	425	347
	02	120	765	994.39	329	-558
	03	121	778	ND	369	419.3
	04	122	792	427.32	489	-124.3
	05	123	790	757.99	505	-473
	06	124	773	752.03	325	-303.7
	07	125	760	372.14	417	-28.9
	08	126	760	228.42	451	74.67
	09	127	782	747.1	401	-365.9
	10	128	790	262.97	341	186.35
	11	129	788	534.9	549	-296
	12	130	774	243.66	253	277.8
	13	131	770	289.48	357	123.8
	14	132	790	240.31	461	88.77
	15	133	766	489	397	-119.8
	16	134	782	496	473	-187
	17	135	779	650	397	-267.8
	18	136	764	457	321	-13.64
	19	137	777	504	437	-163.8
	20	138	763	820	257	-313.5
	21	139	786	413.4	333	39.9
BED	01	140	792	847.8	533	-598.8
	02	141	779	ND	537	242
	03	142	785	ND	409	376
	04	143	746	779.8	433	-466.7
	05	144	763	721	461	-400
	06	145	760	931.5	465	-636
	07	146	781	529.6	381	-129
	08	147	766	517.6	477	-228.5
	09	148	762	751	589	-578
	10	149	761	317.5	301	142.9
	11	150	767	758.8	389	-380.6
	12	151	776	582.6	349	-155.3
	13	152	773	590.9	537	-355
	14	153	776	299.2	569	-92.34
POST	01	154	765	741	353	-328.7
	02	155	746	513.6	417	-184
	03	156	795	598.7	357	-160
	04	157	776	776.9	425	-425.8
	05	158	781	653.6	369	-241
	06	159	810	535.1	457	-182.1
	07	160	770	534.3	437	-201.3
	08	161	749	527.2	309	-87.2
	09	162	767	513.6	345	-91.6
	10	163	761	648.2	329	-216.2
	11	164	793	242.9	437	113.1
	12	165	775	486.3	369	-80.3
	13	166	773	514.65	353	-94.65
	14	167	771	337.5	509	-75.5

BAYLOR BED REST - PHASE I
Sodium Balance (mEq)

SUBJECT: 2

STUDY	DAY	JUL DAY	NA-IN	NA-FECAL	NA-URINE	NA-DELTA
PRE	01	119	185	ND	255	-70
	02	120	210	7.114	180	22.9
	03	121	186	ND	99	87
	04	122	246	.431	171	74.57
	05	123	218	2.213	266	-50.12
	06	124	187	6.926	159	21.074
	07	125	171	8.88	150	12.12
	08	126	207	8.39	261	-62.39
	09	127	186	3.48	51	131.5
	10	128	230	4.06	168	57.94
	11	129	214	15.8	332	-133.8
	12	130	187	12.59	74	100.4
	13	131	184	13.72	168	2.28
	14	132	211	15.28	190	5.72
	15	133	180	12.32	156	11.68
	16	134	231	2.44	221	7.56
	17	135	213	2.88	209	1.12
	18	136	187	2.19	138	46.81
	19	137	186	1.49	201	-16.49
	20	138	224	3.22	77	143.78
	21	139	190	1.48	125	63.52
BED	01	140	239	4.91	319	84.91
	02	141	220	ND	260	-40
	03	142	196	ND	168	28
	04	143	174	1.06	161	11.94
	05	144	253	.5	195	57.5
	06	145	179	1.72	160	17.28
	07	146	228	.82	188	39.18
	08	147	228	.55	191	36.45
	09	148	186	3.88	236	-53.88
	10	149	177	1.04	144	31.96
	11	150	253	4.81	176	72.19
	12	151	181	2.94	188	-9.94
	13	152	223	3.41	226	-6.41
	14	153	239	1.53	239	-1.53
POST	01	154	186	9.66	78	98.34
	02	155	174	4.75	122	47.25
	03	156	265	1.1	172	91.9
	04	157	177	10.53	166	.47
	05	158	223	8.59	177	37.41
	06	159	223	10.43	197	15.57
	07	160	195	10.55	286	-101.5
	08	161	175	5.12	126	43.88
	09	162	231	14.18	174	42.82
	10	163	182	12.23	133	36.77
	11	164	224	2.42	186	35.58
	12	165	212	6.947	165	40.053
	13	166	186	12.344	215	-41.344
	14	167	188	16.232	172	-1.232

BAYLOR BED REST - PHASE I
Potassium Balance (mEq)

SUBJECT: 2

STUDY	DAY	JUL DAY	K-IN	K-FECAL	K-URINE	K-DELTA	
PRE	01	119	82	ND	80	2	
	02	120	93	26.979	72	-5.98	
	03	121	81	ND	60	21	
	04	122	101	9.506	73	18.5	
	05	123	78	18.654	84	-24.6	
	06	124	81	20.31	65	-4.3	
	07	125	90	25.31	52	12.69	
	08	126	89	12.43	77	-.43	
	09	127	82	19.01	40	22.99	
	10	128	103	12.14	45	45.86	
	11	129	78	16.16	73	-11.16	
	12	130	77	10.22	47	19.88	
	13	131	93	21.27	69	2.73	
	14	132	132	94	22.03	63	8.
	15	133	74	16.47	57	12.15	
	16	134	101	13.71	78	9.29	
	17	135	75	17.57	63	-5.57	
	18	136	80	12.69	76	-8.69	
	19	137	90	14.98	86	-10.98	
	20	138	86	23.56	44	18.44	
	21	139	79	10.89	52	16.11	
BED	01	140	103	19.43	62	21.57	
	02	141	77	ND	58	19	
	03	142	80	ND	71	9	
	04	143	87	14.49	83	-10.49	
	05	144	91	14.56	74	2.44	
	06	145	77	23.47	82	-28.47	
	07	146	105	12.97	79	13.03	
	08	147	69	13.16	67	-11.16	
	09	148	78	21.9	74	-17.9	
	10	149	91	8.08	48	34.92	
	11	150	93	20.99	72	.01	
	12	151	82	15.73	66	.27	
	13	152	101	16.63	77	7.37	
	14	153	75	15.99	77	-17.99	
POST	01	154	78	17.52	54	6.48	
	02	155	87	12.96	63	11.04	
	03	156	96	8.27	56	31.73	
	04	157	77	20.55	46	10.45	
	05	158	103	17.00	68	18.0	
	06	159	81	16.12	55	9.88	
	07	160	83	19.34	64	-.34	
	08	161	88	12.65	61	14.35	
	09	162	91	16.22	83	8.22	
	10	163	73	19.85	58	-4.85	
	11	164	102	4.59	70	27.41	
	12	165	75	16.314	57	1.686	
	13	166	82	20.763	54	7.237	
	14	167	98	15.278	86	-8.278	

BAYLOR BED REST - PHASE I
Chloride Balance (mEq)

SUBJECT: 2

STUDY	DAY	JUL DAY	CL-IN	CL-FECAL	CL-URINE	CL-DELTA
PRE	01	119	136	ND	215	079
	02	120	185	2.86	154	28.14
	03	121	154	ND	91	63
	04	122	216	.7	124	91.3
	05	123	156	1.62	253	-98.62
	06	124	160	2.39	161	-3.39
	07	125	161	3.39	132	25.61
	08	126	186	2.13	224	-40.13
	09	127	154	1.4	53	99.6
	10	128	203	.69	133	69.31
	11	129	153	1.18	294	-142
	12	130	160	.89	83	76.11
	13	131	169	.88	157	11.12
	14	132	189	4.32	162	22.68
	15	133	152	5.57	129	17.43
	16	134	206	2.19	197	6.81
	17	135	152	2	188	-30
	18	136	186	1.76	125	59.24
	19	137	174	1.78	169	3.22
	20	138	202	2.96	65	134
	21	139	159	.98	116	42
BED	01	140	209	2.71	244	-37.71
	02	141	157	ND	230	-73
	03	142	167	ND	159	8
	04	143	166	.83	158	7.17
	05	144	227	.7	167	59.3
	06	145	152	1.81	152	-1.81
	07	146	204	1.05	169	33.95
	08	147	167	.92	174	-7.92
	09	148	159	2.06	228	-71.06
	10	149	167	.55	127	39.45
	11	150	228	2.85	156	69.15
	12	151	153	1.32	162	-10.32
	13	152	201	1.22	193	6.78
	14	153	168	.42	206	-38.42
POST	01	154	159	2.88	83	73.12
	02	155	166	1.12	102	62.88
	03	156	235	2.05	145	87.95
	04	157	152	2.98	141	8.02
	05	158	200	2.65	170	27.35
	06	159	157	3.18	167	-13.18
	07	160	169	2.99	264	-97.99
	08	161	166	1.54	120	44.46
	09	162	206	4.69	162	39.31
	10	163	153	3.4	124	25.6
	11	164	256	.66	184	71.34
	12	165	149	2.011	150	-3.011
	13	166	159	3.113	196	-40.173
	14	167	175	4.086	202	-31.086

BAYLOR BED REST - PHASE I
Magnesium Balance (mEq)

SUBJECT: 2

STUDY	DAY	JUL DAY	MG-IN	MG-FECAL	MG-URINE	MG-DELTA
PRE	01	119	28	ND	11.1	16.9
	02	120	24	15.44	8.2	.36
	03	121	28	ND	7.4	20.6
	04	122	25	5.952	9.9	9.148
	05	123	24	10.835	10.6	2.565
	06	124	20	11.698	7.5	.802
	07	125	24	10.98	7.9	5.12
	08	126	22	5.5	7.4	9.1
	09	127	28	9.16	13.6	5.24
	10	128	25	6.64	7.4	10.96
	11	129	24	9.35	10.3	4.35
	12	130	18	6.63	7.5	3.87
	13	131	24	7.03	5.9	11.07
	14	132	25	8.22	7.6	9.18
	15	133	26	7.35	6.5	12.15
	16	134	25	7.34	7.1	10.56
	17	135	23	9.25	9.6	4.15
	18	136	19	6.65	8.1	4.25
	19	137	24	4.87	9.5	9.63
	20	138	21	8.44	5.8	6.76
	21	139	27	4.05	7.6	15.15
BED	01	140	25	10.09	7.2	7.71
	02	141	24	ND	8.6	15.4
	03	142	19	ND	9.4	9.6
	04	143	23	11.40	6.9	4.7
	05	144	22	8.75	8.1	5.15
	06	145	26	9.43	152	-1.81
	07	146	26	6.08	6.7	13.22
	08	147	22	7.41	9.6	4.99
	09	148	18	10.25	9.7	-1.95
	10	149	24	3.61	11.9	8.49
	11	150	23	9.67	9.6	3.73
	12	151	28	7.00	7.9	13.1
	13	152	25	8.00	9.1	7.9
	14	153	24	4.55	10.6	8.85
POST	01	154	18	12.05	66	-.65
	02	155	23	5.81	10.0	7.19
	03	156	24	6.75	8.1	9.15
	04	157	27	8.42	10.0	8.58
	05	158	25	9.38	11.8	3.82
	06	159	24	8.49	11.2	4.31
	07	160	20	8.58	7.9	3.52
	08	161	23	5.86	8.0	9.14
	09	162	22	7.17	8.8	6.03
	10	163	26	7.65	9.9	8.45
	11	164	26	2.84	9.8	13.26
	12	165	33	10.564	9.7	22.436
	13	166	19	11.133	8.4	-533
	14	167	24	6.918	8.5	8.582

BAYLOR BED REST - PHASE I
Nitrogen Balance (gm)

SUBJECT: 2

STUDY	DAY	JUL DAY	N-IN	N-FECAL	N-URINE	N-DELTA
PRE	01	119	15.63	ND	14.5	1.13
	02	120	15.76	3.5	13.8	-1.54
	03	121	15.68	ND	12	3.68
	04	122	16.43	1.5	13.6	1.33
	05	123	15.76	2.5	15.5	-2.24
	06	124	14.64	2.63	10.1	1.91
	07	125	17.3	3.24	12.6	1.46
	08	126	15.94	4.73	15.3	-4.09
	09	127	15.87	2.70	14.6	-1.43
	10	128	15.86	1.37	13.7	.79
	11	129	15.54	2.34	13.7	-.5
	12	130	16.19	1.73	10.2	4.26
	13	131	17.22	2.28	11.1	3.84
	14	132	16.43	2.08	14.5	-.15
	15	133	15.84	2.24	12.83	.77
	16	134	16.03	1.46	14.45	.12
	17	135	15.26	2.2	13.58	-.52
	18	136	14.3	1.55	11.77	.98
	19	137	17.68	1.24	14.55	1.89
	20	138	15.6	2.31	10.81	2.48
	21	139	16.59	1.23	12.85	2.51
BED	01	140	16.02	2.25	14.5	-.73
	02	141	15.1	ND	11.51	3.59
	03	142	14.36	ND	12.36	3
	04	143	16.67	2.43	12.47	1.77
	05	144	17.31	2.19	16.04	-.92
	06	145	15.6	2.79	13.1	-.29
	07	146	15.62	1.39	13.73	.5
	08	147	15.02	1.65	13.74	-.37
	09	148	14.37	2.39	14.36	-2.38
	10	149	16.99	.92	10.74	5.33
	11	150	17.89	2.66	12.85	2.38
	12	151	15.84	2.06	13.69	.09
	13	152	15.45	1.71	14.3	-.56
	14	153	15.02	1.01	15.22	-1.21
POST	01	154	14.37	2.47	10.1	1.8
	02	155	16.67	1.59	15	.08
	03	156	18.8	1.55	13.72	3.53
	04	157	15.6	2.44	11.98	1.18
	05	158	15.46	1.83	11.94	1.69
	06	159	15.39	1.91	12.57	.91
	07	160	14.48	2.53	10.12	1.83
	08	161	16.67	1.66	11.14	3.87
	09	162	17.81	1.78	14.56	1.47
	10	163	16.00	2.10	13.58	0.32
	11	164	15.38	.71	12.24	2.43
	12	165	15.02	1.86	11.77	1.39
	13	166	14.37	2.30	12.33	-0.26
	14	167	[illegible].14	1.86	11.29	3.99

BAYLOR BED REST - PHASE I
Phosphorus Balance (mg)

SUBJECT: 2

STUDY	DAY	JUL DAY	P-IN	P-FECAL	P-URINE	P-DELTA
PRE	01	119	1508	ND	1104	404
	02	120	1521	777.58	1060	-316.58
	03	121	1514	ND	1036	478
	04	122	1732	386.39	1144	201.61
	05	123	1478	753.66	1096	0397
	06	124	1453	724.94	790	-61.94
	07	125	1620	865.04	868	-113.04
	08	126	1584	419.05	1074	90.95
	09	127	1526	578.55	946	1.45
	10	128	1677	371.71	1021	284.29
	11	129	1476	759.02	848	-131.02
	12	130	1435	572.88	818	39.11
	13	131	1631	669.85	896	75.15
	14	132	1635	522.68	1232	-199.68
	15	133	1522	424.42	870	227.58
	16	134	1704	391.65	1113	199.45
	17	135	1455	553.77	1122	-220.77
	18	136	1446	388.96	1104	-46.96
	19	137	1645	394.88	1234	-16.12
	20	138	1565	TF	925	TF
	21	139	1575	TF	1037	TF
BED	01	140	1698	TF	1040	TF
	02	141	1434	ND	994	440
	03	142	1506	ND	1069	437
	04	143	1568	TF	906	TF
	05	144	1668	TF	1212	TF
	06	145	1500	TF	984	TF
	07	146	1684	TF	1021	TF
	08	147	1400	TF	1035	TF
	09	148	1430	TF	1062	TF
	10	149	1605	TF	835	TF
	11	150	1676	TF	1154	TF
	12	151	1540	TF	1090	TF
	13	152	1649	TF	1070	TF
	14	153	1427	TF	1238	TF
POST	01	154	1431	TF	859	TF
	02	155	1568	TF	1195	TF
	03	156	1754	TF	1151	TF
	04	157	1507	TF	1142	TF
	05	158	1659	TF	1008	TF
	06	159	1477	TF	1177	TF
	07	160	1457	TF	808	TF
	08	161	1569	TF	1071	TF
	09	162	1675	TF	1240	TF
	10	163	1534	TF	1303	TF
	11	164	1648	TF	1018	TF
	12	165	1431	TF	952	TF
	13	166	1442	TF	1175	TF
	14	167	1618	TF	1085	TF

BAYLOR BED REST STUDY - PHASE I
Body Weight, Fecal Weight, Water Balance & Nitrogen Balance
Statistics

SUBJECT: 3

STUDY DAY: TOTAL BED REST STUDY

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	69.5652	192.674	1536.28	1.22979
SDEV	.428571	104.692	847.487	3.31610
SIZE	49	39	49	49
SUM	3408.69	7514.30	75278.1	60.2600

STUDY DAY: PRE 01 TO PRE 21

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	69.4619	158.411	1663.43	1.26904
SDEV	.514087	61.7763	900.100	3.15657
SIZE	21	18	21	21
SUM	1458.70	2851.40	34932.1	26.6500

STUDY DAY: BED 01 TO BED 14

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	69.5857	196.350	889.357	1.23000
SDEV	.374312	130.228	553.905	4.26547
SIZE	14	10	14	14
SUM	974.200	1963.50	12451.0	17.2200

STUDY DAY: POST 01 TO POST 14

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	69.7000	262.630	1992.50	1.17071
SDEV	.274862	112.783	630.654	2.65951
SIZE	14	10	14	14
SUM	975.800	2626.30	27895.0	16.3900

BAYLOR BED REST - PHASE I
Mineral Statistics

SUBJECT: 3

STUDY DAY: TOTAL BED REST STUDY

	CA-DELTA	P-DELTA	NA-DELTA	K-DELTA	MG-DELTA	CL-DELTA
MEAN	-111.150	215.780	36.0943	7.53812	9.01130	36.5319
SDEV	508.795	490.753	44.0246	28.9729	8.23097	48.2257
SIZE	49	27	49	49	49	49
SUM	-5446.38	5826.06	1768.62	369.368	441.554	1790.06

STUDY DAY: PRE 01 to PRE 21

MEAN	-39.2557	22.7931	48.0194	11.8270	9.45243	59.8019
SDEV	313.474	445.790	40.1369	17.1402	6.12692	51.7378
SIZE	21	19	21	21	21	21
SUM	-824.370	433.070	1008.40	248.367	198.501	1255.84

STUDY DAY: BED 01 TO BED 14

MEAN	-131.485	713.250	5.02285	-2.92143	8.97858	7.0435
SDEV	578.145	274.458	41.9837	25.9468	8.41925	32.4495
SIZE	14	4	14	14	14	14
SUM	-1840.80	2853.00	70.3199	-40.9000	125.7000	98.609

STUDY DAY: POST 01 TO POST 14

MEAN	-198.658	635.000	49.2781	11.5643	8.38236	31.1153
SDEV	673.324	139.257	38.1924	42.5350	10.9896	39.6657
SIZE	14	4	14	14	14	14
SUM	-2781.21	2540.00	689.893	161.901	117.353	435.614

BAYLOR BED REST - PHASE I
Water Balance (ml)

SUBJECT: 3

STUDY	DAY	JUL DAY	W-IN	W-FECAL	W-URINE	W-DELTA
PRE	01	119	4715	ND	1810	2905
	02	120	3110	48.79	1800	1261.21
	03	121	4570	187.25	2000	2382.75
	04	122	3532	56.89	1620	1855.11
	05	123	4013	72.25	1715	2225.75
	06	124	3402	161.33	1800	1440.67
	07	125	2061	113.51	2270	-322.51
	08	126	3464	ND	1720	1744
	09	127	4792	195.55	2580	2016.45
	10	128	3883	76.27	2115	1691.73
	11	129	4568	ND	2350	2218
	12	130	3390	155	1490	1745
	13	131	2025	115	1840	70
	14	132	3721	169	2340	1212
	15	133	3804	34	1880	1890
	16	134	3552	125	2990	437
	17	135	3531	93	1900	1538
	18	136	3240	161	2400	679
	19	137	3794	138	1460	2196
	20	138	4071	167	1620	2284
	21	139	5189	86	1640	3463
BED	01	140	3357	272	2740	345
	02	141	4160	ND	3450	710
	03	142	3537	ND	1740	1797
	04	143	3468	114	2270	1198
	05	144	3549	69	2615	865
	06	145	4321	157	2340	1824
	07	146	3357	115	2240	1002
	08	147	3762	355	3120	287
	09	148	3014	12	2881	121
	10	149	3717	119	3020	578
	11	150	3474	ND	2510	964
	12	151	4485	276	2630	1579
	13	152	3342	58	2425	859
	14	153	3462	ND	3140	322
POST	01	154	3926	327	2180	1419
	02	155	4081	55	1730	2296
	03	156	3512	ND	2180	1332
	04	157	4335	114	1680	2541
	05	158	3903	293	2230	1380
	06	159	4807	ND	2030	2777
	07	160	3366	228	2235	903
	08	161	3418	ND	1240	2178
	09	162	3372	222	2245	3150
	10	163	4460	232	2050	2178
	11	164	4234	ND	1820	2414
	12	165	3587	161	1905	1521
	13	166	3184	120	1090	1974
	14	167	3389	297	1260	1832

BAYLOR BED REST - PHASE I
Calcium Balance (mg)

SUBJECT: 3

STUDY	DAY	JUL DAY	CA-IN	CA-FECAL	CA-URINE	CA-DELTA
PRE	01	119	785	ND	353	43.23
	02	120	789	300.1	397	92.12
	03	121	800	969.15	325	-494.13
	04	122	825	440.35	277	108.1
	05	123	821	443	329	49.3
	06	124	824	465.29	489	-130.3
	07	125	808	291.9	393	123.3
	08	126	830	ND	333	497.3
	09	127	826	424.55	369	32.7
	10	128	837	132.41	248	456.1
	11	129	822	ND	345	477.3
	12	130	821	524.52	232	64
	13	131	833	394.38	325	114
	14	132	825	417	529	-121
	15	133	812	595	369	-151.74
	16	134	841	804	417	-380
	17	135	824	780	285	-240.5
	18	136	827	1101	417	-690.8
	19	137	827	953	240	-366.5
	20	138	831	828	377	-373.7
	21	139	837	545.7	224	66.85
BED	01	140	843	317.8	385	140.4
	02	141	820	ND	313	507.4
	03	142	885	ND	261	624.5
	04	143	817	1016.1	333	-531.7
	05	144	837	637	497	-297
	06	145	849	1217.9	361	-729.6
	07	146	840	856.9	269	-285
	08	147	818	1316.4	613	-1111.6
	09	148	832	92.7	409	330.5
	10	149	820	771	445	-395.9
	11	150	850	ND	413	437.2
	12	151	838	1431.8	409	-1001.6
	13	152	835	419.8	433	-17.7
	14	153	854	ND	365	489.3
POST	01	154	841	2100	357	-1615.7
	02	155	800	201.3	277	321.7
	03	156	842	ND	393	449
	04	157	815	599.9	317	-101.5
	05	158	827	1081.9	493	-747.9
	06	159	837	ND	305	532.4
	07	160	827	1520.4	429	-1122.4
	08	161	812	ND	369	443
	09	162	849	1278.5	353	-782.5
	10	163	825	986.2	337	-498.2
	11	164	851	ND	305	546
	12	165	831	730.79	337	-236.79
	13	166	818	448.79	297	72.21
	14	167	802	556.53	285	-40.53

BAYLOR BED REST - PHASE I
Sodium Balance (mEq)

SUBJECT: 3

STUDY	DAY	JUL DAY	NA-IN	NA-FECAL	NA-URINE	NA-DELTA
PRE	01	119	287	ND	192	95
	02	120	252	.597	266	-14.597
	03	121	284	4.355	206	73.645
	04	122	281	.496	234	46.504
	05	123	289	.914	217	71.086
	06	124	245	1.191	202	41.809
	07	125	237	1.52	250	-14.52
	08	126	241	ND	234	7
	09	127	287	3.31	253	30.69
	10	128	280	1.22	190	88.78
	11	129	289	ND	270	19
	12	130	246	3.71	149	93.29
	13	131	247	2.05	221	23.95
	14	132	240	2.25	254	16.25
	15	133	287	.99	212	74.01
	16	134	287	1.31	284	1.69
	17	135	285	2.14	191	91.86
	18	136	252	2.53	246	3.47
	19	137	247	1.55	170	75.45
	20	138	242	4.12	173	64.88
	21	139	289	.84	169	119.16
BED	01	140	295	9.29	310	-24.29
	02	141	290	ND	285	5
	03	142	288	ND	250	38
	04	143	246	1.75	280	-35.75
	05	144	275	.82	309	-34.82
	06	145	297	1.91	220	75.09
	07	146	289	1.47	256	31.53
	08	147	285	17.01	349	-81.01
	09	148	277	.23	282	-5.23
	10	149	236	1.69	260	-25.69
	11	150	270	ND	217	53
	12	151	289	5.41	254	29.59
	13	152	289	1.1	257	30.9
	14	153	297	ND	283	14
POST	01	154	276	4.61	186	85.39
	02	155	232	2.53	196	33.47
	03	156	265	ND	216	49
	04	157	286	2.5	216	67.5
	05	158	283	5.13	220	57.87
	06	159	288	ND	161	127
	07	160	275	5.04	267	2.96
	08	161	231	ND	159	72
	09	162	252	7.32	234	10.68
	10	163	273	9.77	265	-1.77
	11	164	269	ND	242	27
	12	165	258	3.316	202	52.684
	13	166	275	2.119	177	95.881
	14	167	232	19.772	202	10.228

BAYLOR BED REST - PHASE I
Potassium Balance (mEq)

SUBJECT: 3

STUDY	DAY	JUL DAY	K-IN	K-FECAL	K-URINE	K-DELTA
PRE	01	119	93	ND	58	35
	02	120	101	7.683	83	10.317
	03	121	95	23.415	82	-10.415
	04	122	120	8.556	78	33.444
	05	123	112	11.364	62	38.636
	06	124	106	11.815	73	21.185
	07	125	94	15.81	73	5.19
	08	126	106	ND	77	29
	09	127	102	32.24	101	-31.24
	10	128	117	12.48	72	32.52
	11	129	113	ND	101	12
	12	130	102	27.67	64	10.33
	13	131	105	20.92	70	14.08
	14	132	109	10.84	98	.16
	15	133	99	16.37	79	3.63
	16	134	123	17.55	108	-2.55
	17	135	115	21.31	78	15.69
	18	136	107	30.65	84	-7.65
	19	137	98	24.11	69	4.89
	20	138	112	24.96	66	21.04
	21	139	108	14.89	80	13.11
BED	01	140	120	30.51	99	-9.51
	02	141	112	ND	90	22
	03	142	119	ND	84	35
	04	143	105	21.51	102	-18.51
	05	144	116	11.88	105	-.88
	06	145	105	27.87	103	-25.87
	07	146	210	21.09	94	4.91
	08	147	110	40.21	134	-64.21
	09	148	109	1.82	104	3.18
	10	149	101	18.42	82	.58
	11	150	110	ND	83	27
	12	151	106	45.45	92	-31.45
	13	152	118	10.14	104	3.86
	14	153	110	ND	97	13
POST	01	154	114	47.9	89	-22.9
	02	155	94	5.78	97	-8.78
	03	156	107	ND	85	22
	04	157	97	17.32	66	13.68
	05	158	115	36.44	91	-12.44
	06	159	107	ND	69	38
	07	160	110	42.78	96	-28.78
	08	161	95	ND	57	38
	09	162	110	36.03	72	1.97
	10	163	105	33.56	90	-18.56
	11	164	218	ND	78	140
	12	165	105	30.258	72	2.742
	13	166	106	18.512	77	10.488
	14	167	97	27.519	83	-13.519

BAYLOR BED REST - PHASE I
Chloride Balance (mEq)

SUBJECT: 3

STUDY	DAY	JUL DAY	CL-IN	CL-FECAL	CL-URINE	CL-DELTA
PRE	01	119	254	ND	154	100
	02	120	225	.12	50	174.88
	03	121	247	2.43	102	142.57
	04	122	253	.32	198	54.68
	05	123	267	.78	185	81.22
	06	124	213	.86	193	19.14
	07	125	224	.96	220	3.04
	08	126	220	ND	206	14
	09	127	254	1.91	194	58.09
	10	128	253	1.54	167	84.46
	11	129	266	ND	212	54
	12	130	213	.24	127	85.76
	13	131	233	.82	201	31.18
	14	132	219	2.1	234	-17.1
	15	133	255	.85	199	55.15
	16	134	261	.5	275	-14.5
	17	135	263	.69	159	103.31
	18	136	215	.95	238	-23.95
	19	137	231	.84	149	81.16
	20	138	220	1.71	144	74.29
	21	139	256	.54	161	94.46
BED	01	140	266	3.01	279	-16.01
	02	141	266	ND	266	0
	03	142	248	ND	219	29
	04	143	232	.18	243	-11.18
	05	144	248	.25	272	-24.25
	06	145	262	1	206	55
	07	146	262	.87	224	37.13
	08	147	262	6.55	321	-65.55
	09	148	240	.07	248	-8.07
	10	149	222	.92	214	7.08
	11	150	246	ND	193	53
	12	151	255	2.23	242	10.77
	13	152	262	.31	233	28.69
	14	153	270	ND	267	3
POST	01	154	239	3.31	185	50.69
	02	155	220	.63	180	39.37
	03	156	242	ND	205	37
	04	157	254	1.18	223	29.82
	05	158	257	1.53	228	27.47
	06	159	264	ND	158	106
	07	160	239	1.59	268	-30.59
	08	161	220	ND	148	72
	09	162	229	1.97	243	-20.97
	10	163	240	2.9	258	-20.9
	11	164	241	ND	229	12
	12	165	234	1.74	194	38.26
	13	166	239	1.062	155	82.938
	14	167	221	6.474	202	12.526

BAYLOR BED REST - PHASE I
Magnesium Balance (mEq)

SUBJECT: 3

STUDY	DAY	JUL DAY	MG-IN	MG-FECAL	MG-URINE	MG-DELTA
PRE	01	119	31	ND	12.7	18.3
	02	120	27	4.422	11.9	9.678
	03	121	31	14.826	10.9	5.274
	04	122	32	6.18	13.5	12.32
	05	123	30	5.999	14.3	9.701
	06	124	15	7.072	9.2	-1.272
	07	125	32	8.28	15.9	7.82
	08	126	28	ND	10.4	17.6
	09	127	35	15.26	12.8	6.94
	10	128	31	4.88	11.4	14.72
	11	129	30	ND	14.3	15.7
	12	130	28	14.99	10.3	2.71
	13	131	34	10.47	8.9	14.63
	14	132	28	5.11	14.5	8.39
	15	133	33	9.39	10.2	13.41
	16	134	32	12.78	12	7.22
	17	135	30	13.48	11.2	5.32
	18	136	29	17.43	13.6	-2.03
	19	137	33	13.73	9.7	9.57
	20	138	28	15.52	9.6	2.88
	21	139	36	8.78	7.6	19.62
BED	01	140	32	17.69	12.1	2.21
	02	141	30	ND	14	16
	03	142	34	ND	13.7	20.3
	04	143	34	13.31	15.8	4.89
	05	144	29	7.61	16.1	5.29
	06	145	36	17.51	11.7	6.79
	07	146	32	12.83	12.9	6.27
	08	147	29	21.07	15.6	-7.67
	09	148	30	1.24	13	15.76
	10	149	34	10.3	11.9	11.8
	11	150	28	ND	10.7	17.3
	12	151	36	25.25	14.2	-3.45
	13	152	31	7.29	12.2	11.51
	14	153	31	ND	13.3	18.7
POST	01	154	31	32.44	10.1	-11.54
	02	155	32	3.31	11	17.69
	03	156	27	ND	12.9	14.1
	04	157	33	11.3	10.8	10.9
	05	158	31	17.32	13.1	.58
	06	159	30	ND	10.3	19.7
	07	160	31	24.18	10.7	-3.88
	08	161	33	ND	11.8	21.2
	09	162	28	21.47	12.6	-6.07
	10	163	35	16.13	10.6	8.27
	11	164	34	ND	11.5	22.5
	12	165	29	16.484	13.4	.884
	13	166	29	12.091	12	16.981
	14	167	32	15.062	10.9	6.038

BAYLOR BED REST - PHASE I
Nitrogen Balance (gm)

SUBJECT: 3

STUDY	DAY	JUL DAY	N-IN	N-FECAL	N-URINE	N-DELTA
PRE	01	119	17.97	ND	12.9	5.07
	02	120	15.97	1.05	13.8	1.12
	03	121	18.03	3.53	13.6	.9
	04	122	19.34	1.46	15.4	2.48
	05	123	17.36	1.59	15	.77
	06	124	18.77	1.79	10.6	6.38
	07	125	19.62	2.77	20	-3.15
	08	126	19.76	ND	13.7	6.05
	09	127	18.43	4.68	21.1	-7.35
	10	128	19.18	1.67	16	1.51
	11	129	17.55	ND	16.4	1.15
	12	130	18.69	3.88	12.4	2.41
	13	131	20	2.87	14.3	2.83
	14	132	19.78	3.43	19.7	-3.35
	15	133	18.29	2.34	14.2	1.75
	16	134	19.38	1.9	16.06	1.42
	17	135	17.47	3.11	13.57	.79
	18	136	18.69	3.9	16.35	-1.56
	19	137	20.86	3.3	14.05	3.51
	20	138	19.68	3.27	14.94	1.47
	21	139	18.67	2.18	14.05	2.44
BED	01	140	19.74	1.3	15.1	3.34
	02	141	17.44	ND	13.63	3.81
	03	142	21.98	ND	13	8.98
	04	143	19.9	2.87	18.18	-1.15
	05	144	22.16	1.82	19.9	.44
	06	145	19.44	3.79	17.67	-2.02
	07	146	19.5	2.78	16.67	.05
	08	147	17.28	2.48	21.09	-6.29
	09	148	21.15	.33	18.44	2.38
	10	149	20.03	2.7	15.49	1.84
	11	150	22.1	ND	14.51	7.59
	12	151	18.77	5.59	18.83	-5.65
	13	152	19.42	1.57	16.05	1.8
	14	153	18.62	ND	16.52	2.1
POST	01	154	21.07	7.39	13.86	-.18
	02	155	19.63	.77	19.44	-.58
	03	156	21.94	ND	17.92	4.02
	04	157	18.29	2.28	17.91	-1.9
	05	158	19.1	3.99	16.99	-1.88
	06	159	17.54	ND	14.47	.307
	07	160	21.07	4.97	16.4	-.3
	08	161	19.79	ND	15.45	4.34
	09	162	22.02	4.34	15.09	2.59
	10	163	18.37	4.01	15.66	-1.3
	11	164	19.55	ND	13.98	5.57
	12	165	17.55	3.6	14.08	-.13
	13	166	20.91	2.91	13.73	4.27
	14	167	19.63	4.1	16.73	-1.2

BAYLOR BED REST - PHASE I
Phosphorus Balance (mg)

SUBJECT: 3

STUDY	DAY	JUL DAY	P-IN	P-FECAL	P-URINE	P-DELTA
PRE	01	119	1651	ND	1158	493
	02	120	1554	262.07	1260	31.93
	03	121	1659	848.27	1240	-429.27
	04	122	1742	352.49	1231	158.51
	05	123	1600	376.72	995	228.28
	06	124	1741	393.74	756	591.26
	07	125	1743	591.22	1271	-119.22
	08	126	1817	ND	963	854
	09	127	1776	1155.61	1651	-1030.61
	10	128	1758	412.81	1142	203.19
	11	129	1611	ND	1034	577
	12	130	1731	961.62	894	-124.62
	13	131	1797	724.87	846	226.13
	14	132	1823	900.56	1404	-481.56
	15	133	1771	605.91	1052	113.09
	16	134	1803	988.71	1075	-260.71
	17	135	1609	851.18	915	-157.18
	18	136	1735	1058.81	1056	-379.81
	19	137	1833	902.36	993	-60.34
	20	138	1844	TF	1555	TF
	21	139	1828	TF	1181	TF
BED	01	140	1810	TF	1260	TF
	02	141	1601	ND	1035	566
	03	142	1938	ND	940	998
	04	143	1786	TF	1135	TF
	05	144	1945	TF	1412	TF
	06	145	1851	TF	1310	TF
	07	146	1793	TF	1165	TF
	08	147	1574	TF	1810	TF
	09	148	1867	TF	1267	TF
	10	149	1763	TF	1027	TF
	11	150	1937	ND	1054	883
	12	151	1812	TF	1368	TF
	13	152	1785	TF	1164	TF
	14	153	1725	ND	1319	406
POST	01	154	1860	TF	1090	TF
	02	155	1739	TF	1314	TF
	03	156	1920	ND	1352	568
	04	157	1758	TF	1411	TF
	05	158	1743	TF	1293	TF
	06	159	1635	ND	1137	498
	07	160	1847	TF	1118	TF
	08	161	1739	ND	918	821
	09	162	1933	TF	1257	TF
	10	163	1791	TF	1312	TF
	11	164	1818	ND	1165	653
	12	165	1640	TF	1105	TF
	13	166	1831	TF	1221	TF
	14	167	1760	TF	958	TF

BAYLOR BED REST STUDY - PHASE 1
Body Weight, Fecal Weight, Water Balance & Nitrogen Balance
Statistics

SUBJECT: 4

STUDY DAY: TOTAL BED REST STUDY

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	64.3196	193.480	1226.11	2.23760
SDEV	.448089	64.4659	682.258	2.73805
SIZE	51	20	51	50
SUM	3280.30	3869.60	62532.0	111.880

STUDY DAY: PRE 01 TO PRE 21

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	64.6095	172.030	1464.05	1.98809
SDEV	.265024	73.8150	672.451	2.02839
SIZE	21	10	21	21
SUM	1356.80	1720.30	30745.1	41.7500

STUDY DAY: BED 01 TO BED 14

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	64.2214	173.825	925.714	2.39143
SDEV	.274862	24.3171	549.081	3.21486
SIZE	14	4	14	14
SUM	899.100	695.300	12960.0	33.4800

STUDY DAY: POST 01 TO POST 14

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	63.9076	249.025	1221.84	2.57833
SDEV	.548891	43.6026	768.594	3.35862
SIZE	13	4	13	12
SUM	830.800	996.100	15884.0	30.9400

BAYLOR BED REST - PHASE I
Mineral Statistics

SUBJECT: 4

STUDY DAY: TOTAL BED REST STUDY

	CA-DELTA	P-DELTA	NA-DELTA	K-DELTA	MG-DELTA	CL-DELTA
MEAN	-9.68687	402.138	36.1041	11.6401	8.13627	36.9409
SDEV	635.421	405.233	54.7037	19.1928	9.73542	49.1831
SIZE	51	39	51	51	51	51
SUM	-494.030	15683.4	1841.31	593.650	414.950	1883.99

STUDY DAY: PRE 01 to PRE 21

MEAN	73.2633	218.495	33.8152	11.8166	8.54333	40.8319
SDEV	472.596	432.694	55.2259	16.4910	6.83128	42.9417
SIZE	21	19	21	21	21	21
SUM	1538.53	4151.41	710.120	248.150	179.410	857.470

STUDY DAY: BED 01 TO BED 14

MEAN	6.85575	543.699	28.6542	10.7307	10.0657	31.0957
SDEV	633.783	299.263	57.5415	15.7808	9.78534	49.2541
SIZE	14	10	14	14	14	14
SUM	95.9805	5437.00	401.160	150.229	140.920	435.340

STUDY DAY: POST 01 TO POST 14

MEAN	-110.662	624.333	45.0242	12.6207	5.60857	34.9350
SDEV	846.269	310.867	48.8993	27.3079	13.4236	53.9248
SIZE	14	9	14	14	14	14
SUM	-1549.27	5619.00	630.340	176.690	78.5200	489.510

BAYLOR BED REST - PHASE I
Water Balance (ml)

SUBJECT: 4

STUDY DAY	JUL DAY	W-IN	W-FECAL	W-URINE	W-DELTA
PRE 01	122	3409	64.42	925	2419.58
02	123	2046	186.51	875	984.49
03	124	2224	ND	1105	1119
04	125	2715	46.69	1430	1265.31
05	126	2462	ND	1715	747
06	127	3931	157.28	1260	2513.72
07	128	2626	69	1415	1142
08	129	2776	ND	2195	581
09	130	2029	ND	1240	789
10	131	2580	173	1780	627
11	132	2654	83	1055	1516
12	133	4299	ND	1900	2399
13	134	3803	ND	1205	2598
14	135	2390	160	1620	610
15	136	2473	ND	940	1533
16	137	2984	ND	1160	1824
17	138	2955	196	400	2359
18	139	3704	166	1690	1848
19	140	2172	ND	970	.1202
20	141	3016	ND	1750	1266
21	142	3122	ND	1720	1402
BED 01	143	2009	115	1490	404
02	144	1461	ND	610	851
03	145	3063	ND	750	2323
04	146	1698	ND	1020	678
05.	147	1857	138	800	919
06	148	1817	ND	1345	472
07	149	1551	ND	960	591
08	150	1640	ND	650	990
09	151	2604	ND	760	1844
10	152	1928	ND	1265	663
11	153	2139	93	1195	851
12	154	1953	ND	910	1043
13	155	2007	126	870	1011
14	156	2530	ND	2210	320
POST 01	157	2395	173	670	1552
02	158	3276	ND	780	2496
03	159	2338	ND	1500	838
04	160	2089	217	1905	-33
05	161	3093	ND	2410	683
06	162	2985	ND	1635	1350
07	163	3538	ND	1050	2488
08	164	2968	ND	715	2253
09	165	2284	ND	1610	674
10	166	2711	155	1180	1376
11	167	2136	151	1120	865
12	168	2846	197	1590	1059
13	169	1676	ND	990	686
14	170	2519	ND	1370	1149

BAYLOR BED REST - PHASE I
Nitrogen Balance (gm)

SUBJECT: 4

STUDY DAY	JUL DAY	N-IN	N-FECAL	N-URINE	N-DELTA
PRE 01	122	17.68	1.21	14.7	1.77
02	123	16.98	2.7	12.7	1.58
03	124	14.38	ND	12.2	2.18
04	125	17.63	1.24	14.2	2.19
05	126	16.26	ND	14.1	2.16
06	127	17.66	3.09	12.7	1.87
07	128	17.1	1.65	14.1	1.35
08	129	17.89	ND	16.1	1.79
09	130	13.06	ND	11.6	1.46
10	131	16.66	3.71	11.6	1.35
11	132	16.06	1.67	13.2	1.19
12	133	17.1	ND	15.35	1.75
13	134	17.12	ND	12.69	4.43
14	135	16.83	3.65	15.12	-1.94
15	136	15.2	ND	10.05	5.15
16	137	16.8	ND	19.24	-2.44
17	138	16.06	4.39	6.12	5.55
18	139	16.1	3.2	13.01	-.11
19	140	16.88	ND	11.52	5.36
20	141	16.83	ND	14.16	2.67
21	142	15.2	ND	12.76	2.44
BED 01	143	16.46	3.07	15.56	-2.17
02	144	16.06	ND	9.89	6.17
03	145	16.1	ND	13.14	2.96
04	146	16.88	ND	13.48	3.4
05	147	16.83	3.35	7.77	5.71
06	148	15.54	ND	14.67	.87
07	149	16.8	ND	14.29	2.51
08	150	18.29	ND	10.69	7.6
09	151	15.86	ND	12.63	3.23
10	152	16.72	ND	20.85	-4.13
11	153	16.83	2.5	13.84	.49
12	154	15.54	ND	10.62	4.92
13	155	16.8	2.69	13.4	.71
14	156	18.29	ND	17.08	1.21
POST 01	157	15.49	4.25	12.11	-.87
02	158	16.88	ND	13.45	3.43
03	159	16.77	ND	16.44	.33
04	160	15.54	TF	13.85	TF
05	161	16.8	ND	17.62	-.82
06	162	18.77	ND	13.33	5.44
07	163	15.86	ND	13.79	2.07
08	164	16.88	ND	7.57	9.31
09	165	16.83	ND	11.46	5.37
10	166	15.54	3.39	14.54	-2.39
11	167	16.8	3.59	14.6	-1.39
12	168	18.29	3.42	13.12	1.75
13	169	15.49	ND	11.08	4.41
14	170	16.88	ND	13.45	3.43

BAYLOR BED REST - PHASE I
Calcium Balance (mg)

SUBJECT: 4

STUDY DAY	JUL DAY	CA-IN	CA-FECAL	CA-URINE	CA-DELTA
PRE 01	122	774	423.6	365	-14.3
02	123	767	837.54	349	-419.2
03	124	713	ND	413	300.17
04	125	772	167.9	393	211.3
05	126	743	ND	453	290.1
06	127	745	293.78	281	170.66
07	128	769	283.43	309	176.9
08	129	783	ND	417	366.17
09	130	698	ND	361	337.28
10	131	738	657.91	281	-200.47
11	132	751	297.07	236	217.46
12	133	779	ND	373	406
13	134	782	ND	285	497.4
14	135	773	1499	373	-1099
15	136	747	ND	457	290.09
16	137	755	ND	361	394.28
17	138	740	1639.1	184	-1083.47
18	139	741	934.8	321	-514.8
19	140	708	ND	389	403.4
20	141	762	ND	337	425.33
21	142	736	ND	353	383.23
BED 01	143	737	1183.6	261	-707.12
02	144	747	ND	220	526.56
03	145	760	ND	265	495.47
04	146	770	ND	481	289.04
05	147	758	1560.2	96	-898.4
06	148	758	ND	437	319.13
07	149	737	ND	385	352.2
08	150	759	ND	273	486.4
09	151	738	ND	341	397.32
10	152	767	ND	521	245.96
11	153	776	1368.9	365	-957.63
12	154	767	ND	317	450.37
13	155	758	1586.4	365	-1193.4
14	156	751	ND	461	290.08
POST 01	157	739	2287.8	273	-1821.3
02	158	785	ND	269	516.46
03	159	768	ND	421	347.16
04	160	747	2110.7	389	-1752.7
05	161	748	ND	401	347.2
06	162	758	ND	353	405.3
07	163	737	ND	341	396.3
08	164	769	ND	228	540.5
09	165	756	ND	[illegible]	[illegible]
10	166	747	1003	461	-717
11	167	737	826.85	393	482.85
12	168	748	1226.3	265	-743.3
13	169	736	ND	220	515.56
14	170	769	ND	345	424

BAYLOR BED REST - PHASE I
Phosphorus Balance (mg)

SUBJECT: 4

STUDY DAY:	JUL DAY	P-IN	P-FECAL	P-URINE	P-DELTA
PRE 01	122	1611	301.1	1277	32.9
02	123	1463	725.74	823	-85.74
03	124	1389	ND	861	528
04	125	1553	301.83	915	336.17
05	126	1545	ND	1132	413
06	127	1602	705.9	1084	-187.9
07	128	1549	439.41	877	235.59
08	129	1553	ND	966	587
09	130	1311	ND	1166	145
10	131	1533	1131.81	926	-524.81
11	132	1564	506.68	992	65.32
12	133	1689	ND	1140	549
13	134	1685	ND	1036	649
14	135	1463	1434.12	972	-943.12
15	136	1522	ND	959	563
16	137	1578	ND	1485	93
17	138	1552	TF	296	TF
18	139	1568	TF	1082	TF
19	140	1583	ND	834	749
20	141	1451	ND	1085	366
21	142	1510	ND	929	581
BED 01	143	1522	TF	1341	TF
02	144	1578	ND	708	870
03	145	1574	ND	858	716
04	146	1666	ND	1122	544
05	147	1440	TF	448	TF
06	148	1552	ND	1076	476
07	149	1540	ND	1075	465
08	150	1672	ND	767	905
09	151	1517	ND	973	544
10	152	1646	ND	1796	-150
11	153	1464	TF	1123	TF
12	154	1579	ND	892	687
13	155	1554	TF	1096	TF
14	156	1662	ND	1282	380
POST 01	157	1482	TF	1045	TF
02	158	1659	ND	998	661
03	159	1553	ND	1230	323
04	160	1540	TF	1029	TF
05	161	1552	ND	1205	347
06	162	1713	ND	818	895
07	163	1515	ND	1323	192
08	164	1657	ND	458	1199
09	165	1439	ND	837	602
10	166	1540	TF	1345	TF
11	167	1540	TF	1075	TF
12	168	1660	TF	1113	TF
13	169	1481	ND	752	729
14	170	1657	ND	986	671

BAYLOR BED REST - PHASE I
Sodium Balance (mEq)

SUBJECT: 4

STUDY DAY	JUL DAY	NA-IN	NA-FECAL	NA-URINE	NA-DELTA
PRE 01	122	287	.43	158	128.57
02	123	286	2.28	232	51.72
03	124	192	ND	221	-29
04	125	244	.81	228	15.19
05	126	239	ND	298	-59
06	127	279	2.06	162	114.94
07	128	276	1.14	264	10.86
08	129	290	ND	281	9
09	130	216	ND	236	-20
10	131	232	4.22	198	29.78
11	132	232	6.58	197	28.42
12	133	242	ND	179	63
13	134	256	ND	139	117
14	135	283	2.73	233	47.27
15	136	238	ND	175	63
16	137	233	ND	236	-3
17	138	231	3.17	96	131.83
18	139	232	4.46	197	30.54
19	140	245	ND	222	23
20	141	282	ND	271	11
21	142	238	ND	292	-54
BED 01	143	232	1.06	274	-43.06
02	144	232	ND	148	84
03	145	240	ND	159	81
04	146	247	ND	275	-28
05	147	282	1.36	153	127.69
06	148	238	ND	266	-28
07	149	231	ND	248	-17
08	150	269	ND	175	94
09	151	213	ND	168	45
10	152	245	ND	287	-42
11	153	283	1.6	215	66.4
12	154	239	ND	185	54
13	155	239	2.87	211	25.13
14	156	269	ND	287	-18
POST 01	157	225	3.45	125	96.55
02	158	289	ND	169	120
03	159	286	ND	264	22
04	160	237	4.07	290	-57.07
05	161	232	ND	241	-9
06	162	232	ND	168	64
07	163	213	ND	139	74
08	164	249	ND	200	49
09	165	282	ND	180	102
10	166	237	5.2	181	50.8
11	167	231	4.27	187	39.73
12	168	228	9.67	234	-15.67
13	169	224	ND	158	66
14	170	249	ND	221	28

BAYLOR BED REST - PHASE I
Potassium Balance (mEq)

SUBJECT: 4

STUDY DAY	JUL DAY	K-IN	K-FECAL	K-URINE	K-DELTA
PRE 01	122	82	7.37	60	14.63
02	123	90	15.77	63	11.23
03	124	66	ND	46	20
04	125	78	6.94	62	9.06
05	126	83	ND	65	18
06	127	76	16.53	62	-2.53
07	128	95	7.63	71	16.37
08	129	92	ND	79	13
09	130	70	ND	57	13
10	131	69	25.88	60	-16.88
11	132	76	24.35	76	-24.35
12	133	86	ND	70	16
13	134	105	ND	63	42
14	135	93	24.07	62	6.93
15	136	89	ND	50	39
16	137	75	ND	74	1
17	138	72	33.76	29	9.24
18	139	78	21.55	59	-2.55
19	140	100	ND	58	42
20	141	89	ND	74	15
21	142	85	ND	77	8
BED 01	143	69	20.55	70	-21.55
02	144	77	ND	57	20
03	145	80	ND	64	16
04	146	103	ND	68	35
05	147	86	23.42	51	11.58
06	148	89	ND	82	7
07	149	72	ND	58	14
08	150	81	ND	55	26
09	151	69	ND	57	12
10	152	102	ND	106	-4
11	153	93	16.08	63	13.92
12	154	94	ND	62	32
13	155	71	21.72	54	-4.72
14	156	77	ND	84	-7
POST 01	157	66	33.76	70	-37.76
02	158	106	ND	61	45
03	159	96	ND	75	21
04	160	85	38.89	80	-33.89
05	161	69	ND	63	6
06	162	78	ND	49	29
07	163	68	ND	48	20
08	164	102	ND	46	56
09	165	85	ND	53	32
10	166	85	23.43	44	17.57
11	167	65	29.56	49	-13.56
12	168	77	26.67	54	-3.67
13	169	66	ND	56	10
14	170	102	ND	73	29

BAYLOR BED REST - PHASE I
Magnesium Balance (mEq)

SUBJECT: 4

STUDY DAY	JUL DAY	MG-IN	MG-FECAL	MG-URINE	MG-DELTA
PRE 01	122	27	3.95	12.5	10.55
02	123	23	10.48	5.7	6.82
03	124	17	ND	8.7	8.3
04	125	22	3.67	10.1	8.23
05	126	21	ND	7.1	13.9
06	127	24	7.11	8.6	8.29
07	128	24	6.1	7.8	10.1
08	129	25	ND	9.1	15.9
09	130	16	ND	10.1	5.9
10	131	17	14.37	7.3	-4.67
11	132	22	13.49	6.8	1.71
12	133	29	ND	12.2	16.8
13	134	26	ND	7.9	18.1
14	135	24	16.52	10.7	-3.22
15	136	24	ND	17.6	6.4
16	137	19	ND	12.3	6.7
17	138	21	20.47	3.6	-3.07
18	139	25	12.03	7.5	5.47
19	140	26	ND	8.5	17.5
20	141	23	ND	9.7	13.7
21	142	23	ND	7	16
BED 01	143	17	15.39	8.1	-6.49
02	144	22	ND	6.9	15.3
03	145	25	ND	7.7	17.3
04	146	26	ND	6.6	19.4
05	147	23	18.6	2.4	2
06	148	25	ND	10.9	14.1
07	149	22	ND	4.1	17.9
08	150	25	ND	7.7	17.3
09	151	25	ND	9.1	15.9
10	152	26	ND	14.1	11.9
11	153	24	17.18	9.8	-2.98
12	154	26	ND	8.2	17.8
13	155	19	18.61	8.8	-8.41
14	156	22	ND	12.1	9.9
POST 01	157	20	24.64	7.9	-12.54
02	158	26	ND	8.8	17.2
03	159	23	ND	10	13
04	160	25	27.29	9.8	-12.09
05	161	18	ND	10.2	7.8
06	162	23	ND	10.3	12.7
07	163	25	ND	11.5	13.5
08	164	26	ND	3.8	22.2
09	165	23	ND	8	15
10	166	25	18.64	19.8	-13.44
11	167	18	18.17	14	-14.17
12	168	22	15.44	8.5	-1.94
13	169	20	ND	7.3	12.7
14	170	26	ND	7.4	18.6

BAYLOR BED REST - PHASE I
Chloride Balance (mEq)

SUBJECT: 4

STUDY DAY	JUL DAY	CL-IN	CL-FECAL	CL-URINE	CL-DELTA
PRE 01	122	250	.7	166	83.3
02	123	265	2.01	180	82.99
03	124	168	ND	197	-29
04	125	227	.72	200	26.28
05	126	218	ND	271	-53
06	127	248	2.73	159	86.27
07	128	248	2.24	224	21.76
08	129	268	ND	239	29
09	130	198	ND	208	-10
10	131	218	1.43	185	31.57
11	132	208	1.12	175	31.88
12	133	207	ND	162	45
13	134	227	ND	133	94
14	135	263	1.73	178	83.27
15	136	218	ND	161	57
16	137	218	ND	194	24
17	138	208	1.14	86	120.86
18	139	204	1.71	164	38.29
19	140	224	ND	176	48
20	141	263	ND	210	53
21	142	218	ND	225	-7
BED 01	143	218	.72	200	17.28
02	144	208	ND	146	62
03	145	205	ND	142	63
04	146	223	ND	237	-14
05	147	263	.33	130	132.67
06	148	218	ND	249	-31
07	149	227	ND	203	24
08	150	240	ND	155	85
09	151	186	ND	144	42
10	152	221	ND	267	-46
11	153	263	.32	202	60.68
12	154	219	ND	188	31
13	155	220	.29	185	34.71
14	156	241	ND	267	-26
POST 01	157	203	.59	130	72.41
02	158	255	ND	144	111
03	159	263	ND	225	38
04	160	218	1.49	280	-63.49
05	161	217	ND	217	0
06	162	78	ND	159	-81
07	163	186	ND	128	58
08	164	224	ND	161	63
09	165	263	ND	177	86
10	166	218	1.3	155	61.7
11	167	217	.6	161	55.4
12	168	200	2.51	196	1.49
13	169	203	ND	156	47
14	170	224	ND	184	40

BAYLOR BED REST STUDY - PHASE I
Body Weight, Fecal Weight, Water Balance & Nitrogen Balance
Statistics

SUBJECT: 5

STUDY DAY: TOTAL BED REST STUDY

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	81.4320	183.787	1645.27	.988800
SDEV	.784544	64.2959	835.618	3.24192
SIZE	50	26	50	50
SUM	4071.59	4778.47	82263.9	49.4400

STUDY DAY: PRE 01 TO PRE 21

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	81.6904	168.755	1819.90	.500952
SDEV	.763762	59.2784	540.750	2.44580
SIZE	21	12	21	21
SUM	1715.50	2025.07	38217.9	10.5200

STUDY DAY: BED 01 TO BED 14

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	81.6357	243.700	993.571	1.41571
SDEV	.488887	8.20441	446.422	3.76049
SIZE	14	2	14	14
SUM	1142.90	487.400	13910.0	19.8200

STUDY DAY: POST 01 TO POST 14

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	80.8999	189.618	1955.78	1.27285
SDEV	.806906	73.7232	1130.27	3.94923
SIZE	14	11	14	14
SUM	1132.60	2085.80	27381.0	17.8200

BAYLOR BED REST - PHASE I
Mineral Statistics

SUBJECT: 5

STUDY DAY: TOTAL BED REST STUDY

	CA-DELTA	P-DELTA	NA-DELTA	K-DELTA	MG-DELTA	CL-DELTA
MEAN	-80.0568	201.033	41.9490	5.19200	7.69919	47.7546
SDEV	637.719	453.145	123.558	22.3329	10.1274	57.8474
SIZE	50	32	50	50	50	50
SUM	-4002.84	6433.06	2097.45	259.600	384.959	2387.73

STUDY DAY: PRE 01 to PRE 21

	CA-DELTA	P-DELTA	NA-DELTA	K-DELTA	MG-DELTA	CL-DELTA
MEAN	28.6424	-23.7018	30.6090	7.94618	8.33666	48.3742
SDEV	397.046	420.957	173.664	18.3135	6.31752	54.9108
SIZE	21	17	21	21	21	21
SUM	601.491	-402.932	642.790	166.869	175.070	1015.86

STUDY DAY: BED 01 TO BED 14

	CA-DELTA	P-DELTA	NA-DELTA	K-DELTA	MG-DELTA	CL-DELTA
MEAN	82.4243	480.583	25.4564	5.81213	11.9364	30.9100
SDEV	604.897	379.229	59.9547	30.1083	10.6346	53.6113
SIZE	14	12	14	14	14	14
SUM	1153.94	5767.00	356.390	81.3699	167.110	432.740

STUDY DAY: POST 01 TO POST 14

	CA-DELTA	P-DELTA	NA-DELTA	K-DELTA	MG-DELTA	CL-DELTA
MEAN	-402.097	356.333	70.9493	.924283	2.54000	61.3721
SDEV	874.682	199.475	76.4097	20.5339	12.7835	67.1912
SIZE	14	3	14	14	14	14
SUM	-5629.37	1069.00	993.290	12.9399	35.5600	859.210

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BAYLOR BED REST - PHASE I
Water Balance (ml)

SUBJECT: 5

STUDY DAY	JUL DAY	W-IN	W-FECAL	W-URINE	W-DELTA
PRE 01	122	3456	ND	1270	2186
02	123	3627	105.43	1045	2476.57
03	124	2716	ND	1020	1696
04	125	3253	174.36	1375	1703.64
05	126	2210	ND	1365	845
06	127	3691	101.86	1000	2589.14
07	128	3139	168	1135	1836
08	129	2957	ND	900	2057
09	130	3150	195	1020	1935
10	131	3011	ND	860	2151
11	132	2651	172	1130	1349
12	133	3207	ND	1120	2087
13	134	2536	46.43	1040	1449.6
14	135	2728	96	1150	1482
15	136	2219	ND	1180	1039
16	137	3399	162	980	2257
17	138	2431	97	700	1634
18	139	3601	76	675	2850
19	140	2782	152	1010	1620
20	141	3052	ND	920	2132
21	142	1943	ND	1100	843
BED 01	143	2122	188	1110	824
02	144	1551	ND	1075	476
03	145	2865	ND	870	1995
04	146	2001	ND	920	1081
05	147	1833	ND	1030	803
06	148	2493	ND	1365	1128
07	149	2187	159	1620	408
08	150	1901	ND	945	956
09	151	2826	ND	1030	1796
10	152	2302	ND	1700	602
11	153	1962	ND	1190	772
12	154	2173	ND	1160	1013
13	155	2194	ND	1390	894
14	156	2352	ND	1190	1162
POST 01	157	3679	201	900	2578
02	158	2036	221	950	865
03	159	2038	135	1130	773
04	160	1591	187	345	1059
05	161	2277	ND	1360	917
06	162	1991	177	880	934
07	163	3898	143	960	2755
08	164	3266	113	1490	1663
09	165	4055	ND	690	3365
10	166	3713	106	715	2892
11	167	2450	101	1250	1099
12	168	2220	79	910	1231
13	169	4763	ND	760	4003
14	170	3923	66	610	3247

BAYLOR BED REST - PHASE I
Nitrogen Balance (gm)

SUBJECT: 5

STUDY DAY	JUL DAY	N-IN	N-FECAL	N-URINE	N-DELTA
PRE 01	122	17.68	ND	13.7	3.98
02	123	16.99	2.75	15.6	-1.36
03	124	14.3	ND	14.2	.1
04	125	17.63	3.12	16	-1.49
05	[illegible]	15.62	ND	15.2	.42
06	127	17.66	2.32	14.3	1.04
07	128	17.1	3.09	16.7	-2.69
08	129	16.98	ND	13.9	3.08
09	130	14.48	3.65	15.4	-4.57
10	131	17.62	ND	15	2.62
11	132	15.6	3.11	14.1	-1.61
12	133	17.66	ND	15.1	2.56
13	134	17.1	1.16	13.49	2.45
14	135	15.76	2.45	15.19	-1.88
15	136	16.29	ND	14.44	1.85
16	137	17.63	3.22	16.25	-1.84
17	138	15.34	1.67	12.64	1.03
18	139	17.66	1.19	13.45	3.02
19	140	17.33	3.06	14.2	.07
20	141	17.36	ND	12.91	4.75
21	142	14.14	ND	15.15	-1.01
BED 01	143	17.63	4.14	14.24	-.75
02	144	15.58	ND	10.16	5.42
03	145	17.66	ND	12.27	5.39
04	146	17.57	ND	10.24	7.33
05	147	17.6	ND	16.75	.85
06	148	16.29	ND	19.06	-2.77
07	149	17.71	4.03	18.52	-4.84
08	150	15.34	ND	9.72	5.62
09	151	17.66	ND	13.15	4.51
10	152	16.5	ND	19.62	-3.12
11	153	17.36	ND	15.67	1.69
12	154	16.29	ND	17.12	-.83
13	155	15.76	ND	14.3	1.46
14	156	14.78	ND	14.92	-.14
POST 01	157	17.66	4.78	14.01	-1.13
02	158	16.5	4.6	13.48	-1.58
03	159	17.36	3.46	15.18	-1.28
04	160	14.48	2.85	3.91	7.72
05	161	15.76	ND	17.72	-1.96
06	162	15.34	3.47	9.06	2.81
07	163	17.66	2.1	14.28	1.28
08	164	16.98	1.89	17.58	-2.49
09	165	17.36	ND	13.6	3.76
10	166	14.48	3.08	13.36	-1.96
11	167	15.6	2.28	16.6	-3.28
12	168	15.34	1.8	12.31	1.23
13	169	17.66	ND	11.44	6.22
14	170	16.5	1.82	6.2	8.48

BAYLOR BED REST - PHASE I
Calcium Balance (mg)

SUBJECT: 5

STUDY DAY	JUL DAY	CA-IN	CA-FECAL	CA-URINE	CA-DELTA
PRE 01	122	781	ND	372	408.2
02	123	797	857.51	341	-408
03	124	799	ND	413	386.17
04	125	782	403.77	409	-30.58
05	126	756	ND	457	299.1
06	127	773	235.01	377	161.23
07	128	769	241.42	309	218.96
08	129	769	ND	385	384.2
09	130	761	1100.6	437	-776.5
10	131	779	ND	433	396
11	132	757	921	425	-588.85
12	133	773	ND	525	247.9
13	134	768	351	377	40.25
14	135	643	709	413	-478.8
15	136	750	ND	409	341.18
16	137	772	903	469	-599.9
17	138	781	384.5	297	99.91
18	139	773	365.1	321	87.26
19	140	776	771.1	389	-383.8
20	141	778	ND	285	493.43
21	142	741	ND	437	304.13
BED 01	143	767	1304.4	417	-954.2
02	144	776	ND	373	403.26
03	145	766	ND	353	413.3
04	146	791	ND	405	386.2
05	147	789	ND	429	360.14
06	148	772	ND	697	74.61
07	149	762	1748.4	641	-1627.7
08	150	772	ND	389	383.2
09	151	772	ND	445	327.11
10	152	786	ND	653	132.7
11	153	765	ND	497	268
12	154	772	ND	485	287.03
13	155	791	ND	401	390.2
14	156	767	ND	457	310.09
POST 01	157	773	2851.2	433	-2511.6
02	158	775	2184.8	401	-1810.6
03	159	776	1375.5	541	-1140.5
04	160	771	834.5	285	-348.5
05	161	816	ND	489	327
06	162	772	1119.6	333	-680.6
07	163	775	514.8	389	-128.9
08	164	786	429.08	469	-112.08
09	165	777	ND	224	552.55
10	166	772	547.08	265	-40.08
11	167	789	403.9	409	-23.9
12	168	774	601.23	329	-156.23
13	169	775	ND	261	514.48
14	170	843	697.41	216	-70.41

BAYLOR BED REST - PHASE I
Phosphorus Balance (mg)

SUBJECT: 5

STUDY DAY	JUL DAY	P-IN	P-FECAL	P-URINE	P-DELTA
PRE 01	122	1637	ND	1118	519
02	123	1521	648.11	1170	-297.11
03	124	1436	ND	1204	232
04	125	1556	885.79	1128	-427.79
05	126	1503	ND	1420	83
06	127	1611	631.88	1320	-340.88
07	128	1550	819.57	1112	-381.57
08	129	1457	ND	1152	305
09	130	1436	1049.95	1092	-705.95
10	131	1554	ND	1135	419
11	132	1503	845.82	1175	-517.82
12	133	1611	ND	1098	513
13	134	1559	302.85	1144	-387.85
14	135	1408	631.96	1150	-373.96
15	136	1571	ND	1204	367
16	137	1551	TF	1215	TF
17	138	1584	TF	812	TF
18	139	1612	TF	1026	TF
19	140	1622	TF	1172	TF
20	141	1604	ND	1104	500
21	142	1406	ND	1364	92
BED 01	143	1526	TF	1199	TF
02	144	1584	ND	774	810
03	145	1610	ND	1044	566
04	146	1652	ND	699	953
05	147	1633	ND	886	747
06	148	1579	ND	1802	-223
07	149	1533	TF	1264	TF
08	150	1558	ND	794	764
09	151	1611	ND	1030	581
10	152	1385	ND	1632	-247
11	153	1601	ND	1119	482
12	154	1579	ND	1322	257
13	155	1511	ND	988	523
14	156	1506	ND	952	554
POST 01	157	1611	TF	1152	TF
02	158	1380	TF	912	TF
03	159	1602	TF	1107	TF
04	160	1391	TF	676	TF
05	161	1540	ND	1414	126
06	162	1558	TF	598	TF
07	163	1611	TF	1440	TF
08	164	1436	TF	1460	TF
09	165	1604	ND	1132	472
10	166	1393	TF	1115	TF
11	167	1505	TF	1150	TF
12	168	1559	TF	1001	TF
13	169	1611	ND	1140	471
14	170	1457	TF	952	TF

BAYLOR BED REST - PHASE I
Sodium Balance (mEq)

SUBJECT: 5

STUDY DAY	JUL DAY	NA-IN	NA-FECAL	NA-URINE	NA-DELTA
PRE 01	122	288	ND	250	38
02	123	290	.92	173	116.08
03	124	254	ND	182	72
04	125	244	4.52	272	-32.52
05	126	243	ND	246	-3
06	127	287	1.29	183	102.71
07	128	247	4.26	220	22.79
08	129	287	ND	158	129
09	130	243	7.38	10.9	224.72
10	131	250	ND	158	92
11	132	244	4.1	301	-661
12	133	287	ND	230	57
13	134	237	1.94	230	5.06
14	135	262	3.22	265	-6.22
15	136	243	ND	268	-25
16	137	245	6.83	146	92.17
17	138	245	2.53	92	150.47
18	139	287	2.06	89	195.94
19	140	244	4.41	225	14.59
20	141	263	ND	197	66
21	142	223	ND	231	-8
BED 01	143	244	3.9	240	.1
02	144	245	ND	220	25
03	145	281	ND	151	130
04	146	247	ND	248	-1
05	147	290	ND	249	41
06	148	244	ND	272	-28
07	149	237	6.71	258	-27.71
08	150	243	ND	164	79
09	151	286	ND	166	120
10	152	245	ND	347	-102
11	153	290	ND	254	36
12	154	244	ND	211	33
13	155	244	ND	206	38
14	156	245	ND	232	13
POST 01	157	287	10.62	122	154.38
02	158	244	7.32	193	43.68
03	159	263	3.39	234	25.61
04	160	247	12.52	233	1.48
05	161	249	ND	280	-31
06	162	243	5.02	171	66.98
07	163	287	9.02	173	104.98
08	164	241	3.53	234	3.47
09	165	263	ND	79	184
10	166	247	2.35	84	160.65
11	167	245	2.68	281	-38.68
12	168	244	2.13	209	32.88
13	169	278	ND	154	124
14	170	248	1.15	86	160.86

BAYLOR BED REST - PHASE I
Potassium Balance (mEq)

SUBJECT: 5

STUDY DAY	JUL DAY	K-IN	K-FECAL	K-URINE	K-DELTA
PRE 01	122	88	ND	85	3
02	123	100	11.64	88	.36
03	124	77	ND	54	23
04	125	77	22.86	84	-29.86
05	126	88	ND	76	12
06	127	82	16.55	73	-7.55
07	128	95	22.56	69	3.44
08	129	86	ND	58	28
09	130	76	22.87	75	-21.87
10	131	80	ND	52	28
11	132	88	22.28	72	-6.28
12	133	82	ND	55	27
13	134	96	16.11	67	12.89
14	135	93	10.71	76	6.29
15	136	89	ND	84	5
16	137	77	20.53	78	-21.53
17	138	96	11.59	53	31.41
18	139	82	10.3	37	34.7
19	140	91	15.13	70	5.87
20	141	87	ND	78	9
21	142	85	ND	61	24
BED 01	143	71	27.01	76	-32.1
02	144	91	ND	48	43
03	145	81	ND	68	13
04	146	91	ND	51	40
05	147	87	ND	66	21
06	148	94	ND	96	-2
07	149	72	29.53	91	-48.53
08	150	90	ND	42	48
09	151	82	ND	65	17
10	152	83	ND	126	-43
11	153	83	ND	74	9
12	154	94	ND	81	13
13	155	75	ND	66	9
14	156	69	ND	75	-6
POST 01	157	82	41.96	65	-24.96
02	158	83	40.87	76	-33.87
03	159	87	22.87	75	-10.87
04	160	89	17.31	63	8.69
05	161	82	ND	88	-6
06	162	90	22.73	45	22.27
07	163	82	1.58	82	-1.58
08	164	82	13.27	79	10.27
09	165	88	ND	64	24
10	166	90	13.1	53	23.9
11	167	74	13.11	90	-29.11
12	168	90	10.28	61	18.72
13	169	82	ND	62	20
14	170	85	10.98	62	12.02

BAYLOR BED REST - PHASE I
Magnesium Balance (mEq)

SUBJECT: 5

STUDY DAY	JUL DAY	MG-IN	MG-FECAL	MG-URINE	MG-DELTA
PRE 01	122	28	ND	10.8	17.2
02	123	25	10.69	10.9	3.41
03	124	18	ND	10.5	7.5
04	125	22	10.63	9.5	1.87
05	126	23	ND	14.7	8.3
06	127	27	6.26	10.5	10.24
07	128	24	7.5	9.4	7.1
08	129	23	ND	10.4	12.6
09	130	18	14.07	10.4	-6.47
10	131	22	ND	10.3	11.7
11	132	23	10.63	8.4	3.97
12	133	27	ND	12.8	14.2
13	134	24	11.18	3.2	9.62
14	135	24	8.49	9.8	5.71
15	136	23	ND	9.8	13.2
16	137	22	11.99	12.9	-2.89
17	138	29	6.32	6.1	16.58
18	139	27	4.67	8	14.33
19	140	25	13.1	9.1	2.8
20	141	23	ND	7.4	15.6
21	142	19	ND	10.5	8.5
BED 01	143	21	14.34	9.2	-2.54
02	144	28	ND	6.4	21.6
03	145	27	ND	8.3	18.7
04	146	25	ND	7.3	17.7
05	147	23	ND	8.2	19.8
06	148	25	ND	7.6	17.4
07	149	22	25.25	11.7	-14.95
08	150	28	ND	6.8	21.2
09	151	27	ND	13.2	13.8
10	152	31	ND	17	14
11	153	23	ND	11.9	11.1
12	154	25	ND	11.5	13.5
13	155	26	ND	9.6	16.4
14	156	10	ND	10.6	-.6
POST 01	157	27	38.25	10.9	-22.15
02	158	31	32.71	10.7	-12.41
03	159	23	21.31	12.9	-11.21
04	160	32	12.38	6.4	13.22
05	161	26	ND	15.6	10.4
06	162	28	20.11	9.4	-15.1
07	163	27	7.38	12.4	7.22
08	164	32	8.21	13.1	10.69
09	165	23	ND	9.5	13.5
10	166	32	16.36	11.7	3.94
11	167	24	11.35	14.9	-2.25
12	168	28	9.83	9.6	8.57
13	169	27	ND	9.7	17.3
14	170	31	7.56	9.6	13.84

BAYLOR BED REST - PHASE I
Chloride Balance (mEq)

SUBJECT: 5

STUDY DAY	JUL DAY	CL-IN	CL-FECAL	CL-URINE	CL-DELTA
PRE 01	122	251	ND	234	17
02	123	267	.96	155	11.04
03	124	222	ND	137	85
04	125	228	2.71	249	-23.71
05	126	218	ND	212	6
06	127	250	.41	173	76.59
07	128	219	.86	199	19.14
08	129	266	ND	129	137
09	130	218	2.16	182	33.84
10	131	229	ND	128	101
11	132	219	2.05	225	-8.05
12	133	250	ND	205	45
13	134	209	1.91	189	18.09
14	135	248	.85	231	16.15
15	136	212	ND	223	-11
16	137	229	1.78	140	87.22
17	138	228	1.4	90	136.6
18	139	251	1.04	70	179.96
19	140	217	2.01	193	21.99
20	141	227	ND	175	52
21	142	193	ND	178	15
BED 01	143	229	2.15	202	24.85
02	144	228	ND	163	65
03	145	250	ND	161	107.7
04	146	219	ND	204	15
05	147	253	ND	223	30
06	148	213	ND	250	-37
07	149	227	.81	217	9.19
08	150	227	ND	133	94
09	151	251	ND	151	100
10	152	225	ND	316	-91
11	153	254	ND	219	35
12	154	213	ND	196	17
13	155	225	ND	170	55
14	156	226	ND	218	8
POST 01	157	251	.65	113	137.35
02	158	224	2.05	208	13.95
03	159	227	12.01	208	6.99
04	160	224	2.36	199	22.64
05	161	228	ND	253	-25
06	162	227	2.39	159	65.61
07	163	252	2.08	170	79.92
08	164	225	1.36	218	5.64
09	165	227	ND	73	154
10	166	224	.86	64	159.15
11	167	226	1.23	255	-30.23
12	168	227	1.02	198	27.98
13	169	242	ND	139	103
14	170	225	.79	86	138.21

BAYLOR BED REST STUDY - PHASE I
Body Weight, Fecal Weight, Water Balance & Nitrogen Balance
Statistics

SUBJECT: 6

STUDY DAY: TOTAL BED REST STUDY

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	64.9860	106.392	959.538	1.08020
SDEV	.711422	49.3827	655.976	4.50078
SIZE	50	39	50	50
SUM	3249.30	4149.30	47976.9	54.0100

STUDY DAY: PRE 01 TO PRE 21

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	64.3619	101.368	939.220	1.74857
SDEV	.385758	61.3810	678.483	4.13911
SIZE	21	16	21	21
SUM	1351.60	1621.90	19723.6	36.7200

STUDY DAY: BED 01 TO BED 14

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	65.3500	101.760	706.785	-.15214
SDEV	.505464	33.4240	427.404	6.50918
SIZE	14	10	14	14
SUM	914.900	1017.60	9895.00	-2.1300

STUDY DAY: POST 01 TO POST 14

	BODY WEIGHT	FECAL WT	W-DELTA	N-DELTA
MEAN	65.6000	111.116	1304.50	1.35857
SDEV	.487480	42.9721	689.892	2.26[illegible]
SIZE	14	12	14	14
SUM	918.400	1333.40	18263.0	19.0200

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BAYLOR BED REST - PHASE I
Mineral Statistics

SUBJECT: 6

STUDY DAY: TOTAL BED REST STUDY

	CA-DELTA	P-DELTA	NA-DELTA	K-DELTA	MG-DELTA	CL-DELTA
MEAN	-45.3050	215.104	24.2192	5.91572	7.53034	26.1508
SDEV	420.318	411.164	54.0032	18.0805	7.99245	46.1995
SIZE	50	25	50	50	50	50
SUM	-2265.25	5377.62	1210.96	295.786	376.517	1307.54

STUDY DAY: PRE 01 to PRE 21

	CA-DELTA	P-DELTA	NA-DELTA	K-DELTA	MG-DELTA	CL-DELTA
MEAN	34.9272	170.110	25.7271	8.02695	9.59272	29.7800
SDEV	379.029	408.045	47.4271	19.3005	8.06994	41.2562
SIZE	21	16	21	21	21	21
SUM	733.471	2721.76	540.270	168.566	201.447	625.380

STUDY DAY: BED 01 TO BED 14

	CA-DELTA	P-DELTA	NA-DELTA	K-DELTA	MG-DELTA	CL-DELTA
MEAN	-212.665	354.020	14.0514	6.46500	4.99071	18.5835
SDEV	427.475	484.536	40.3125	18.2658	9.36486	33.7617
SIZE	14	5	14	14	14	14
SUM	-2977.31	1770.10	196.720	90.5100	69.8699	260.170

STUDY DAY: POST 01 TO POST 14

	CA-DELTA	P-DELTA	NA-DELTA	K-DELTA	MG-DELTA	CL-DELTA
MEAN	49.2565	374.000	35.6978	3.09571	7.85643	29.1000
SDEV	421.738	325.887	73.8743	17.2409	5.22275	64.6837
SIZE	14	3	14	14	14	14
SUM	689.591	1122.00	499.770	43.3400	109.990	407.400

BAYLOR BED REST - PHASE I
Water Balance (ml)

SUBJECT: 6

STUDY DAY	JUL DAY	W-IN	W-FECAL	W-URINE	W-DELTA
PRE 01	122	3085	51.94	1450	1583
02	123	2559	45.72	1295	1218
03	124	1497	121.73	1280	95.27
04	125	2061	36.44	1050	974.56
05	126	1809	ND	1160	649
06	127	2910	150.21	1080	1679.8
07	128	1974	ND	1425	549
08	129	2482	32	1765	685
09	130	2031	81	1110	840
10	131	2025	72	1340	613
11	132	597	ND	1035	-438
12	133	2970	16	840	2114
13	134	2169	45	1120	1004
14	135	1929	ND	1610	319
15	136	1812	24	1220	568
16	137	1806	113	1030	663
17	138	1748	55	880	813
18	139	3015	69	360	2586
19	140	2169	55	880	1234
20	141	2367	165	805	1397
21	142	1917	ND	1340	577
BED 01	143	1764	39	1375	350
02	144	1896	ND	1065	831
03	145	3229	34	1480	1715
04	146	1938	ND	840	1098
05	147	2367	87	1730	550
06	148	1800	58	810	932
07	149	2130	87	1320	723
08	150	1677	ND	1270	407
09	151	3129	88	3170	-129
10	152	1974	43	970	961
11	153	2148	84	1430	634
12	154	2148	88	1200	860
13	155	1914	ND	1390	524
14	156	1956	72	1445	439
POST 01	157	3464	86	1110	2268
02	158	1905	75	720	1110
03	159	2148	94	1260	794
04	160	1791	ND	1545	246
05	161	1892	134	1370	388
06	162	2243	38	810	1395
07	163	3204	55	860	2289
08	164	2315	82	1005	1228
09	165	2732	36	735	1961
10	166	2034	89	1015	930
11	167	2136	ND	1390	746
12	168	2071	36	1130	905
13	169	3282	95	1150	2037
14	170	2499	123	410	1966

BAYLOR BED REST - PHASE I
Nitrogen Balance (gm)

SUBJECT: 6

STUDY DAY	JUL DAY	N-IN	N-FECAL	N-URINE	N-DELTA
PRE 01	122	17.66	1.39	21.2	-4.93
02	123	16.99	1.1	14.2	-1.69
03	124	14.43	2.85	11.1	.48
04	125	18.22	.95	14.4	2.87
05	126	16.02	ND	13.6	2.42
06	127	14.61	3.52	12.7	-1.61
07	128	14.45	ND	1.67	12.78
08	129	14.34	.82	11.6	1.92
09	130	15.78	1.97	10.7	3.11
10	131	15.09	1.82	11.8	1.47
11	132	14.82	ND	13.9	.92
12	133	14.61	.84	10.18	3.59
13	134	14.72	3.09	11.53	-.1
14	135	13.95	ND	12.17	1.78
15	136	15.78	.71	10.99	4.08
16	137	15.09	9.05	13.4	-7.36
17	138	14.82	1.47	12.2	1.15
18	139	14.61	1.92	4.11	8.58
19	140	14.4	1.16	11.14	2.1
20	141	13.95	3.19	9.51	1.25
21	142	15.98	ND	12.07	3.91
BED 01	143	15.09	1.04	10.66	3.39
02	144	14.82	ND	12.18	2.64
03	145	14.61	.96	15.9	-2.25
04	146	12.29	ND	9.31	2.98
05	147	13.95	2.38	14.76	-3.19
06	148	15.74	1.41	8.96	5.37
07	149	15.09	2.18	11.14	1.77
08	150	14.82	ND	13.34	1.48
09	151	14.61	2.41	33.51	-21.31
10	152	14.61	1.11	11.17	2.33
11	153	13.95	1.88	11.87	.2
12	154	15.78	2.06	11.54	2.18
13	155	15.09	ND	12.02	3.07
14	156	14.82	1.67	13.94	-.79
POST 01	157	14.61	1.98	11.89	.74
02	158	12.3	1.58	9.71	1.01
03	159	13.95	1.8	10.89	1.26
04	160	15.74	ND	11.62	4.12
05	161	15.09	2.77	11.52	.8
06	162	14.82	1.59	11.19	2.54
07	163	14.61	1.37	12.15	1.09
08	164	14.4	1.65	12.18	.57
09	165	13.95	.93	10.17	2.85
10	166	15.79	1.72	11	3.07
11	167	15.09	ND	17.5	-2.41
12	168	14.82	1	14.5	-.68
13	169	14.61	2.26	14.34	-1.97
14	170	14.45	2.57	5.85	6.03

BAYLOR BED REST - PHASE I
Calcium Balance (mg)

SUBJECT: 6

STUDY DAY	JUL DAY	CA-IN	CA-FECAL	CA-URINE	CA-DELTA
PRE 01	122	775	571.9	481	-277.86
02	123	780	420.64	409	-49.45
03	124	724	1098.32	337	-711
04	125	793	162.15	361	270.13
05	126	781	ND	401	376.19
06	127	812	468.45	317	26.92
07	128	825	ND	373	452.25
08	129	814	156.4	683	-25.4
09	130	821	390.59	309	121.41
10	131	796	352.39	389	54.61
11	132	772	ND	361	411.28
12	133	820	207	277	336
13	134	816	412	257	147.49
14	135	801	ND	349	452.3
15	136	817	332	277	208
16	137	794	1244	301	-750.6
17	138	781	611.8	361	-191.8
18	139	820	826.5	128	-134.76
19	140	813	317.8	281	214.64
20	141	806	1221.7	248	-664.2
21	142	808	ND	341	467.32
BED 01	143	799	430.2	401	-32.2
02	144	797	ND	457	340
03	145	815	479.7	794	-462.7
04	146	764	ND	345	419
05	147	806	1178.7	565	-937.7
06	148	809	629.3	345	-165.3
07	149	804	929.7	473	-598.7
08	150	795	ND	497	298.09
09	151	814	1038.6	449	-673.5
10	152	827	496.1	461	-130
11	153	804	801.9	481	-478.9
12	154	799	741.5	479	-419.4
13	155	804	ND	509	295
14	156	773	759	445	-431
POST 01	157	819	849.5	349	-379.2
02	158	783	705.8	601	-524
03	159	804	787.2	309	-291.8
04	160	806	ND	341	465.32
05	161	799	1151.5	281	518.44
06	162	781	498.6	289	492.4
07	163	815	570.72	297	-52.72
08	164	810	656.3	285	525.4
09	165	806	301.94	240	264.06
10	166	823	467.26	261	94.74
11	167	809	ND	273	536.46
12	168	776	470.86	309	-3.86
13	169	817	1050.3	325	-558.3
14	170	826	1095.1	128.25	-397.35

BAYLOR BED REST - PHASE I
Phosphorus Balance (mg)

SUBJECT: 6

STUDY DAY	JUL DAY	P-IN	P-FECAL	P-URINE	P-DELTA
PRE 01	122	1612	469.1	1537	-394.1
02	123	1464	356.24	932	175.76
03	124	1412	982.24	666	-236.24
04	125	1595	349.68	945	300.32
05	126	1539	ND	812	727
06	127	1476	1267.93	907	-698.93
07	128	1711	ND	1368	343
08	129	1568	237.46	847	483.54
09	130	1689	719.47	843	126.53
10	131	1572	724.87	804	43.13
11	132	1537	ND	1346	191
12	133	1477	221.51	857	398.49
13	134	1722	988.71	1075	-341.71
14	135	1543	ND	1127	416
15	136	1687	301.03	952	433.97
16	137	1572	TF	1030	TF
17	138	1538	TF	1126	TF
18	139	1477	TF	346	TF
19	140	1701	TF	1038	TF
20	141	1544	TF	869	TF
21	142	1692	ND	938	754
BED 01	143	1544	TF	798	TF
02	144	1546	ND	1129	417
03	145	1477	TF	1154	TF
04	146	1504	ND	756	748
05	147	1544	TF	1073	TF
06	148	1682	TF	923	TF
07	149	1573	TF	950	TF
08	150	1546	ND	1092	454
09	151	1477	TF	796	TF
10	152	1722	TF	892	
11	153	1544	TF	515	-478.9
12	154	1668	TF	912	TF
13	155	1575	ND	945	630
14	156	1539	TF	1156	TF
POST 01	157	1479	TF	844	0
02	158	1464	TF	893	TF
03	159	1544	TF	958	TF
04	160	1679	ND	1082	597
05	161	1579	TF	986	TF
06	152	1541	TF	1134	TF
07	163	1477	TF	894	TF
08	164	1700	TF	1146	TF
09	165	1544	TF	926	TF
10	166	1690	TF	731	TF
11	167	1581	ND	1056	525
12	168	1538	TF	1333	TF
13	169	1477	TF	1012	TF
14	170	1712	TF	508	TF

BAYLOR BED REST - PHASE I

Sodium Balance (mEq)

SUBJECT: 6

STUDY DAY	JUL DAY	NA-IN	NA-FECAL	NA-URINE	NA-DELTA
PRE 01	122	287	1.089	267	18.9
02	123	293	1.365	246	45.6
03	124	203	2.83	226	-25.83
04	125	249	.51	206	42.49
05	126	250	ND	235	15
06	127	218	2.1	204	11.9
07	128	308	ND	296	12
08	129	218	1.01	265	-48
09	130	219	2	150	67
10	131	212	1.71	233	-22.71
11	132	215	ND	214	1
12	133	224	.69	145	78.3
13	134	270	.69	215	54.3
14	135	216	ND	241	-25
15	136	219	.51	207	11.49
16	137	211	1.73	207	2.27
17	138	222	.76	192	29.24
18	139	224	1.24	58	164.76
19	140	258	9.29	198	50.71
20	141	217	2.15	141	73.85
21	142	218	ND	235	-17
BED 01	143	217	.86	244	-27.86
02	144	217	ND	244	-27
03	145	218	.8	185	32.2
04	146	239	ND	168	71
05	147	217	2.16	250	-35.16
06	148	218	1.58	166	50.42
07	149	218	2.06	210	5.94
08	150	216	ND	237	-21
09	151	218	2.41	129	86.59
10	152	263	.84	197	65.16
11	153	217	2.06	226	-11.06
12	154	220	1.92	205	13.08
13	155	218	ND	221	-3
14	156	217	1.59	218	-2.59
POST 01	157	219	1.96	105	112.04
02	158	238	1.38	123	113.62
03	159	217	2.14	227	-12.19
04	160	217	ND	246	-29
05	161	211	2.94	241	-32.94
06	162	217	1.08	160	55.92
07	163	218	1.15	178	38.85
08	164	258	2.03	239	16.97
09	165	217	1.49	120	95.51
10	166	219	2.93	165	51.07
11	167	218	ND	248	-30
12	168	185	1.66	280	-96.66
13	169	219	2.53	182	34.47
14	170	259	2.89	74	182.11

BAYLOR BED REST - PHASE I
Potassium Balance (mEq)

SUBJECT: 6

STUDY DAY	JUL DAY	K-IN	K-FECAL	K-URINE	K-DELTA
PRE 01	122	82	10.338	80	-8.34
02	123	92	7.844	64	20.156
03	124	70	23.63	53	-6.63
04	125	79	7.58	70	1.42
05	126	91	ND	57	34
06	127	90	30.18	67	-7.18
07	128	92	ND	84	8
08	129	82	6.74	60	15.26
09	130	82	18.31	49	14.69
10	131	79	16.66	56	6.34
11	132	69	ND	78	-9
12	133	92	3.34	48	40.16
13	134	91	10.56	78	2.44
14	135	81	ND	93	-12
15	136	81	5.75	57	18.25
16	137	79	27.66	71	-19.66
17	138	71	13.25	58	-.25
18	139	92	16.57	18	57.43
19	140	91	30.51	62	-1.51
20	141	81	34.01	56	-9.01
21	142	79	ND	55	24
BED 01	143	76	9.73	53	13.27
02	144	73	ND	53	20
03	145	90	8.74	74	7.26
04	146	83	ND	50	33
05	147	81	19.29	95	-33.29
06	148	80	13.09	41	25.91
07	149	81	20.21	59	1.79
08	150	73	ND	79	-6
09	151	90	20.78	62	9.22
10	152	93	10.59	62	20.41
11	153	80	21.59	76	-17.59
12	154	85	20.28	53	11.72
13	155	81	ND	64	17
14	156	69	13.19	68	-12.19
POST 01	157	90	17.15	76	-3.15
02	158	81	19.44	70	-8.44
03	159	81	21.62	58	1.38
04	160	80	ND	96	-16
05	161	79	26.21	77	-24.21
06	162	69	8.87	61	-.87
07	163	90	13.4	66	10.6
08	164	90	19.07	75	-4.07
09	165	81	8.23	44	28.77
10	166	82	19.2	43	19.8
11	167	81	ND	70	11
12	168	69	8.46	76	-15.46
13	169	90	22.08	60	7.92
14	170	92	26.93	29	36.07

SUMMARY

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From the initial examination of the bedrested subjects' data, it seems that many of the changes were similar in kind, if not degree, to those of the crew members postflight. Changes produced by this bedrest study similar to those found in crew members returning from spaceflight include responses of cardiovascular, endocrine, hematopoietic and neuromuscular systems. The bedrest period produced responses in these systems without the weight loss which characterizes a return from spaceflight.

Two out of six subjects in this study had presyncopal episodes during the first LBNP test postbedrest compared with four of the nine Skylab crew members. The mean decrease in calf circumference during the bedrest period was -2.6 ±0.3% ($p \leq 0.05$), which is considerably less than the -7.6 ±0.5% decrease found in the Skylab crew members at recovery, but greater than the -1.4% found in a 7-day study. These results are directly comparable since the three studies were performed by the same investigators. (1,2) During maximal stress (-50 mm Hg) of the lower body negative pressure test (LBNP), the changes in leg volume were not statistically different from those seen during the control period, and the magnitude of

individual change did not correlate well with the occurance of syncope. These findings are consistent with those of Bartok et al., and Menninger et al., who found the maximum change in leg volume during tilt or LBNP to be the same pre- and postbedrest. (3,4)

While calf size decrease is greater in spaceflight than in bedrest, the changes in calf size produced by LBNP postflight and postbedrest are only slightly different. Crews of Apollo and Skylab missions showed only a 10% greater increase in leg volume postflight during maximum LBNP. This contrasts with Skylab inflight measurements which showed an 83% greater calf LBNP volume. (5) It appears, therefore, that large shifts in blood volume are more easily produced inflight. The fluid which shifts headward either remains in the vascular system or is available to it in that it produces a significantly greater distension of the calves during LBNP. The shift of blood volume is greater than the horizontal position produces either postflight or postbedrest. Because the calf distension during LBNP is not greater postbedrest and only slightly greater postflight, and because an antigravity suit only partially prevents orthostatic intolerance, venous pooling does not seem a completely adequate explanation for the similar degree of orthostatic intolerance

seen in the crews and bedrested subjects.

During maximum LBNP stress the increase in heart rate (HR) from the resting value for all six subjects was greater post-bedrest: averaging +28% prebedrest and +42.5% postbedrest. Subjects 3 and 4, who were presyncopal on the first postbedrest day, showed the largest incremental increase in HR both during the control phase and on R +0. Chobanian found similar HR directional increases with tilting, but his subjects were less stressed during control tilting (13% increase). After one week of bedrest the tilt-induced increase in HR was greater. He found a 32% increase following 3 days of bedrest, 62% after one week and 89% after three weeks. (6)

Basal heart rate during sleep was not measured, but no significant change was found with bedrest in the radial pulse measured daily at 0700. Other investigators have found a gradual increase of 0.4 beats/day beginning with the fourteenth day of bedrest. (7,8) This study was probably too short to record this change. The mean heart rate measured at 0700 on R +0 by the nurse was 68.3 ±7.8, while during the rest period prior to LBNP, it was 75.2 ±5.8 postbedrest on R +0. The change of posture from the supine to the sitting position before the exercise testing produced a 23 beats/minute increase, while in the control tests it had produced only a 13.5 beats/minute increase. During bicycle ergometer testing, heart rates

were elevated at each work load on R +0 with a mean heart rate at 75 watts equal to that observed at the highest work load prior to bedrest. This was 100 watts for three subjects and 125 for two.

The subjects increased their mechanical efficiency on the bicycle ergometer during the three control studies indicating a learning effect ($p \leq 0.05$). Presumably, since they were for the most part nonbicyclers, they were able to decrease the amount of extraneous or nonmeasured work associated with pedaling the bicycle. Although there was a change in mechanical efficiency during the control phase, there was no change pre- and postbedrest when the last control test is compared to the postbedrest test. These findings are in agreement with those of Hyatt and Saltin, who also found no change pre- and post-bedrest. (7,9) Saltin did not even find changes in mechanical efficiency after an extensive training program. The changes noted in this study thus appear to be an initial acclimation process which disappears after the first couple of test periods on the bike.

A decreased plasma volume or a decreased plasma volume with extravascular dehydration and thus increased plasma extravasation during tilt or exercise have been popular exaplanations for the orthostatic intolerance and decreased exercise tolerance seen postflight and postbedrest. Hyatt

postulated that extravasulcar dehydration produced increased capillary filtration during tilt postbedrest further diminishing the already reduced volume of blood available to the heart. This theory was based primarily on water balances and determinations of extracellular fluid (ECF) and total body water (TBW). Average positive water balance of his subjects decreased from 738 ±226 ml/day to 439 ±104 ml/day (Δ 300 ml/day) during bedrest. (9) This statistically significant decrease was interpreted by him as coming from the interstitial fluid. In a later study, he found a 6% decrease in ECF which supported this theory. (10) In our study the net change in water balance was 630 ml/day, approximately two times greater than the change noted by Hyatt in his bedrested subjects. We found however a nonsignificant 1% decrease in extracellular fluid with no weight loss, although the classical postrecumbency cardiovascular changes were present. We believe that the water balance changes in this study resulted from differences in insensible water loss between the control period when the subjects exercised outside in Houston's warm weather and the bedrest period when the subjects were confined to airconditioned quarters. The experimental design could be partially responsible for our finding of no change in ECF. Control values for ECF and TBW were measured three weeks prior to bedrest on the day that the subjects began the relatively high salt content

study diet. Thus small changes in ECF during bedrest could have been masked by slight increases in ECF during the three week control phase on a high salt diet. However, no weight gain was recorded. The ECF results are at least equivocal and do not support the postulated theory of extravascular dehydration.

The centrifugation studies of van Beaumont, Greenleaf and Juhos also indicate that the absolute decrease in plasma volume is more important than is transfer of fluids out of the vascular system. They found a two-fold greater loss of plasma volume during centrifugation prebedrest than postbedrest, although acceleration tolerance was significantly reduced postbedrest; and in centrifugation studies of experimentally dehydrated individuals, they found progressively smaller losses of plasma volume with increasing levels of dehydration. (11) If there is a correlation between centrifugation tolerance and tilt tolerance and the mechanisms associated with them, then the transfer of fluids out of the vascular system during tilt does not seem to be a definitive reason for the orthostatic intolerance.

During the submaximal exercise, plasma extravasation is also unlikely in that plasma seems to be pumped back into the vascular system even in the presence of extravascular dehydration. After submaximal exercise van Beaumont et al., like

Åstrand and Saltin's cross-country skiers in a cold environment showed an 11% plasma volume increase even after having lost 5.5% of their body weight, and steel workers in a hot environment increased plasma volume 5% while losing 1.9% body weight. (12,13)

In van Beaumont's study there did appear to be a correlation between the decrease in measured plasma volume postbedrest and acceleration tolerance. They overlooked this correlation, however, because they tended to doubt their measured plasma volumes and preferred to use the calculated ones. The difference between their measured and calculated plasma volume could have resulted easily from a decrease in red cell mass which is now known to occur during bedrest.

In our study both the red cell mass and plasma volume decreased during the bedrest period. The mean plasma volume decrease was 6.9%. This is somewhat less than the mean decrease found in subjects of other bedrest studies which approaches 10%, but it is greater than the mean decrease recorded in the returning Apollo and Skylab crew members. Hoffler has found a very significant negative correlation ($r = -0.54$, $p \leq 0.005$) between the orthostatically stressed heart rate and decrease in plasma volume postflight. (5) The plasma volume changes appear related to the orthostatic instability seen postbedrest and decreased exercise tolerance; yet, the exact relationship is

unclear and perhaps complicated. The literature gives a complex and sometimes confused picture.

Saltin thermally dehydrated healthy males before having them exercise. (14) Their 5.2% decrease in body weight was associated with up to 25% decrease in plasma volume. In these studies he found a very strong correlation between the decrease in plasma volume and stroke volume at submaximal levels of exercise in the sitting position. When the subjects exercised supine, however, the increase in heart rate and decrease in stroke volume disappeared. These results are in contrast to a later study of his when he bedrested individuals. Postbedrest he found significant increases in heart rate and decreases in stroke volume not only with upright treadmill exercise, but also with supine bicycle exercise. (7) Hyatt found similar results in supine exercised subjects postbedrest. (9) If plasma volume were the only factor operative, one would expect that facilitating venous return by having the subject exercise in the supine position would normalize heart rate and stroke volume as it did in the dehydrated subjects.

Chobanian felt that plasma volume decreases contributed, but did not explain totally the orthostasis following bedrest. With increasing periods of recumbency he found partial return of the plasma volume toward control values even while the tachycardia induced during tilt was increasing. On the other

hand, Bohnn et al. have used 9-alpha flurohydrocortisone (9-alpha) to prevent both the plasma volume decrease and the orthostatic instability of bedrest. (15) Stevens et al. used both occlusive cuffs and 9-alpha during the last few days of bedrest to restore the bedrest decrease in plasma volume; yet, they found no significant effect on orthostatic intolerance. (16) It is possible that 9-alpha may have pharmacological effects other than those recorded in the plasma volume which are a result of sodium retention. For example, changes in the sodium content of the vascular system may account in part for the prevention of the cardiovascular changes.

Saltin, because he found decreased stroke volume even when venous return was facilitated by the supine position, postulated an unidentified cardiac effect as the cause of the impaired circulatory adaptation to muscular exercise post-bedrest. He thought that blood volume decreases of the magnitude seen in his study could not totally explain the cardiovascular effects noted. (7) Decreases in cardiac size were seen in this study and postflight. Since no measurements were made in Hyatt's or Stevens' studies, it is unknown what portion of the decrease in heart size can be attributed to the decrease in blood volume and whether the cardiac size would be normal when 9-alpha is used to restore the blood volume to normal.

Aldosterone urinary excretion was increased during flight when measured in the Skylab crew members. Generally, aldosterone excretion is not increased in bedrested subjects. In this study a statistically significant increase in urinary aldosterone excretion was noted when the first and second six days of bedrest (17 ±2 μg/day SE) were compared to the last six days of the control period (14 ±1 μg/day SE). This was accompanied by a statistically significant increase in urinary free cortisol from 45 ±4 μg/day to 71 ±5 μg/day during the first six days and 77 ±7 μg/day during the second six days of bedrest. Both aldosterone and cortisol should have produced sodium retention; yet, mean urinary sodium increased significantly, about 40 meq/day ($p \leq 0.05$) during bedrest even though dietary intake did not change. This was accompanied by a 10 meq/day increase in potassium excretion. Other bedrest studies have shown similar results. Thus even an increase in salt retaining steroids did not prevent the negative sodium balance which characterizes bedrested subjects. The mean daily difference in sodium balances was 17.9 meq/day when the control period is compared with the bedrest period. This agrees closely with the 18.3 meq/day found by Hyatt. An 18 meq/day mean loss in sodium could translate into a 225 meq loss or 1.67 liter loss in ECF if the sodium loss were entirely from the extracellular space. This would have produced a nearly 10% decrease in ECF,

but only a statistically insignificant 1% decrease was found indicating much of the sodium loss was from bone. The small or no loss in ECF found in this study contrasts with Hyatt's bedrest study where the ECF loss was statistically significant being about one liter or 6%. It is possible that the difference between the two studies could be ascribed to the increased aldosterone and free cortisol excretion of the subjects in this bedrest study. Increased aldosterone secretion would have protected against a loss of ECF volume but not against sodium loss from bone. The present study does not furnish support to the theory that the water and sodium loss of bedrested subjects results from decreased ADH and aldosterone excretion since statistically significant increases in aldosterone occurred with no change in antidiuretic hormone during the bedrest period. Therefore, a nonhornomal cause for the sodium loss must be sought. If the sodium loss is mostly osseous in origin, it would be reflecting atrophy of bone. Bone atrophy would be accompanied by a loss of calcium.

Urinary calcium increased from 7.9 ±0.4 to 10.0 ±0.6 meq/day the first six bedrest days and 10.8 ±0.4 meq/day during the second six-day period of bedrest. This was accompanied by a mean change in calcium balance of 111 mg/day or 5.5 meq/day. This modest increase in calcium loss would not be expected to produce the degree of naturesis and water diuresis

found in the bedrest period. Unlike Skylab, no increase in urinary phosphorus was found in the bedrest period. Net balance measured from the diet and urinary and fecal excretion actually became more positive. This is difficult to reconcile with the calcium and sodium results. It may indicate a procedural error in the phosphorus determinations.

The vestibular, postural and electromyography findings do not parallel closely the findings of the Skylab crew members. The subjects' sensitivity to motion sickness postbedrest varied. The number of head movements a subject could do prebedrest varied considerably on different days. Therefore, it is not possible to say whether an increased susceptibility occurred. All subjects exhibited mild ataxia for several hours upon getting out of bed, which was particularly noticeable when they turned corners. In the future, dynamic balancing tests might be necessary to document this deficit since the static balancing tests did not show it. The amplitude of the monosynaptic muscle potentials was increased, although no decrease in reflex reaction time was noted. During bedrest mean urinary norepinephrine decreased from 44 ±3 to 32 ±3 μg/day but this change was not significant statistically. Urinary norepinephrine excretion would be expected to decrease during bedrest since rising from the supine position causes norepinephrine levels to increase significantly and acutely. Relatively

higher norepinephrine levels could be a cause of the increased amplitude in the monosynaptic muscle potentials recorded in this study.

This 14-day bedrest study of six subjects faithfully followed the dietary, specimen collection routine and medical testing of Skylab. Our study was designed to prepare the personnel and facilities for a full-scale 28-day simulation of Skylab II. A large body of useful data was collected. The results have shown that this study design can produce biochemical and physiological responses which are similar in kind to other bedrest studies. The quality of accumulated data furnished by the various Skylab investigators and their personnel have made it a study whose total contribution compares favorably with other studies of similar length, even though it was designed as only a preliminary study.

Analyses of these results have helped confirm many post-bedrest findings described in the medical literature. The results have raised questions also about theories formulated to explain the findings recorded when bedrested subjects attempt to return to upright activities.

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